CRCs—Capturing Creativity
through People, Ideas and Enterprise

Recent highlights of the Cooperative Research Centres Program 2002

Established and supported under the Australian Governmment's Cooperative Research Centres Program

Foreword

CRCs—Capturing Creativity through People, Ideas and Enterprise provides an excellent snapshot of some of the achievements of the Government's Cooperative Research Centres Program. It illustrates the contributions of CRCs to achieving world-class research and innovation for the benefit of Australia.

The case studies highlighted are based on applications for the CRC Association's annual Technology Transfer Awards. The Awards recognise the capacity of CRCs to transform ideas into tangible benefits—especially products and services. I was delighted to have the opportunity to present the awards at the Association's annual conference in May 2002.

The CRC Program brings together universities, research organisations, government agencies, industry and other users of research, strengthening collaboration and maximising research and development and innovation carried out in Australia.

There are currently 62 CRCs sharing in more than $145 million per year of Government funding. The Government has committed over $1.8 billion to CRCs under the CRC Program since its inception. Participating organisations, including universities, industry, research agencies, state governments and others, have committed total resources of $5.5 billion.

The CRCs highlighted in the booklet cover a wide range of sectors including mining and energy, environment, manufacturing technology, medical science and technology, information and communication technology, and agriculture and rural based manufacturing.

There is widespread recognition that our nation's fortunes over the coming decades will be largely determined by our ability to generate and support innovation. The Government's 2001 innovation statement, *Backing Australia's Ability*, is providing $2.9 billion in new funding in a concerted effort to stimulate further innovation. This funding commitment is intended to strengthen Australia's ability to generate innovative ideas and research, to accelerate commercial application of those ideas, and to develop and retain locally developed skills.

The CRC Program is the flagship program in realising all three of those objectives.

As we can see from the student presentations highlighted in the booklet, CRCs are providing world class opportunities for students to engage in cutting edge research.

The CRCs featured in CRC Highlights 2002 have each made a substantial contribution to achieving national benefits through providing solutions to many of our environmental, economic and social needs. I warmly congratulate them on their efforts and look forward to hearing of further success stories in the future.

Peter McGauran
Minister for Science
October 2002

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Introduction

Welcome to CRCs—Capturing Creativity through People, Ideas and Enterprise.

Why the title?

People, because CRCs employ around 2000 of the best scientists, educators and commercial directors in Australia, and are currently training almost 1500 postgraduate students.

Ideas, because ideas are fundamental to research, and the collaborative nature of CRCs creates the perfect environment in which ideas can flourish and be developed to their full potential.

Enterprise, because CRCs necessarily involve a variety of partners with complementary expertise, which facilitates the use of the knowledge generated in a myriad of ways, be it improving agricultural production, protecting the environment, or developing marketable products or ventures. Further, many CRCs form spin-off companies to commercialise the intellectual property arising from their CRC, often with the direct involvement of their original research team.

As noted at this year's CRC Association Conference, CRCs have become leaders in turning scientific excellence into new products, new businesses, new expertise and new ways of doing things.

The stories presented in this booklet cover a diverse array of topics, and are based on entries in the 2002 Awards for Technology Transfer. This year, the judges found the standard of the entries so high that they decided to award four awards, rather than the usual three. The winners of the Awards were: the CRC for Tissue Growth and Repair for the development of three new, globally focused biotechnology companies; the CRC for Cochlear Implant and Hearing Aid Innovation for developing SoundShield™ software for protecting those using telephone headsets from acoustic shock; the CRC for International Food Manufacture and Packaging Science for developing biodegradable, starch-based packaging to replace plastics; and the CRC for Eye Research and Technology for developing a soft contact lens that can be worn continuously for 30 days and nights.

In addition, there are fascinating stories of: reducing costs and environmental impact while improving safety in hydrometallurgy; getting the community involved raising leafhoppers for weed management; increasing the efficiency of cast metals manufacturing; improving weather forecasting and 'nowcasting'; using a 'report card' to improve environmental monitoring in Moreton Bay; and the list goes on!

The *Showcasing of CRC PhD Students*, instigated in 2001 and sponsored in both years by CSIRO, attracted an array of talented applicants, eight of whom were invited to attend the conference and present either a 10 or 3 minute presentation of their work. Success was based on their ability to communicate effectively about a research achievement to a non-specialist audience—an increasingly important skill as we endeavour to raise public awareness of how science influences daily life. We congratulate the winner, Dr John Heap, from the CRC for Australian Weed Management.

Once again, we proudly present all these stories to give you a snapshot of the impressive and innovative approaches being made to taking research from ideas to implementation—truly capturing creativity.

A listing of the current CRC Association Members and their contact details is included at the end of this publication, or visit our web site at <http://www.crca.asn.au>.

No More Shrieks and Screams

CRC for Cochlear Implant and Hearing Aid Innovation

Award winner

In our burgeoning world of tele-commerce, the 'call centre' industry is increasingly a major employer. Most of us may have experienced the annoyance of being 'on hold' to a corporate call centre, but spare a moment's thought for the operators in these centres who are daily at risk of hearing loss from 'acoustic shrieks' in their phone lines. While it might take only a second to whip a hand-held receiver away from your ear, operators spend long hours answering phone calls wearing headsets to leave their hands free for computer work, so whipping off the headset is not a viable solution.

There are more than 180,000 operators in Australia alone and the risk to their health from sudden, intense sounds (with a wide variety of causes) can be serious—especially if they have the volume up because everyone around them is talking into the phone.

The CRC for Cochlear Implant and Hearing Aid Innovation (CRC HEAR) has devised a means of protecting these workers through development of shriek-limiting software that recognises and blocks high-pitched sounds in a few hundredths of a second, without significantly affecting the speech that is present at the same time and in the same frequency range. All the operator hears is a scarcely audible 'pip'.

CRC HEAR has licensed the software to Telstra and Polaris Communications. Polaris, a Victorian company has manufactured a device, known as SoundShield™, incorporating the CRC's software, for use both in Australia and overseas. Polaris, which was formerly an importer and distributor of telephony equipment, has now become a manufacturer.

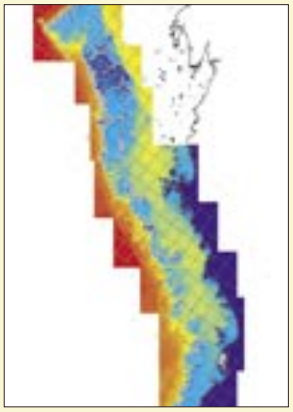
CRC HEAR's technological innovation has led to greater health safety for Australian workers, created new jobs, replaced imports with locally made products and helped develop a product which can expect to earn around $5 million a year, including a substantial export market.

Safe Pontoons on the Reef

CRC for the Great Barrier Reef World Heritage Area

Australia's Great Barrier Reef is one of the great natural wonders of the world. Every year about 1.6 million people visit it, injecting around $1 billion annually into the nation's economy. So, as well as responsibility for people's safety, comfort and holiday enjoyment, tourism operators on the reef have a large financial responsibility.

There are many ways of looking at and enjoying the reef, but one of the most popular depends on pontoons. These are used as heliports and seaplane bases as well as boat moorings, and some offer visitors substantial facilities. This means that pontoons intended for use on the reef can take a long time to build and are very costly.



Cyclones are a big threat to these structures. Not only may they be badly damaged in a cyclone, if the pontoon drags, the reef will also be harmed, destroying the attraction that brings the tourists.

Hence, researchers from the CRC for the Great Barrier Reef World Heritage Area (CRC Reef), based at James Cook University, worked together with the tourism industry and the Great Barrier Reef Marine Park Authority to develop guidelines for constructing and locating pontoons so that they can withstand the most extreme conditions.

Researchers used computer models to simulate more than 6000 cyclones on the reef and then generated a computerised atlas which allows operators to check the size, direction and speed of winds and waves at more than 150,000 sites on the reef. The atlas, together with the CRC Reef guidelines, will help engineers and tourism operators to construct 'smarter', lighter pontoons located in positions chosen to minimise environmental impact and reduce the chance of cyclone damage.

This is not just good news for a multi-million dollar industry but also for the millions of visitors to the Great Barrier Reef.

Crops, Water and Salt

CRC for Sustainable Rice Production

These days most people are aware of the significant problems farmers are facing from salinity in the irrigation areas of the Murray–Darling Basin. The CRC for Sustainable Rice Production has funded CSIRO Land and Water studies resulting in the creation of models for understanding the movement of water and salt in relation to irrigation farming at both farm and irrigation-district levels.

The research involved hydrological studies of more than 560,000 hectares of farmland in the Murrumbidgee and Coleambally Irrigation Areas, where produce worth around $500 million is grown, together with more than 700,000 hectares north of the Murray with an annual farm-gate production of $250 million.

The new software tools have helped to devise rational options for land and water management. One of the most innovative of these tools is a farm-scale hydrological economic model called SWAGMAN Farm (Salt Water And Groundwater MANagement), which is being used not just for irrigation, but as an educational and management tool for irrigation companies, environmental officers and on other types of farms across Australia.

The software has also attracted interest from other nations and international bodies such as the International Rice Research Institute. It has led to UNESCO naming the Murrumbidgee catchment as a global reference basin for its HELP (Hydrology for Environment, Life and Policy) for the rest of the world.

Since the hydrological studies help to decide where best to grow crops to achieve maximum irrigation efficiency, interest from places as far apart as South Africa and China is scarcely surprising. And since the SWAGMAN software is unique, there is widespread interest in acquiring and applying it.

What began as a way to help local irrigators is rapidly becoming an essential tool for improving agricultural productivity and profitability in other parts of Australia and the rest of the world.

Researching for the Golden Touch

AJ Parker CRC for Hydrometallurgy

For hundreds of years humans have panned for gold, but today the preferred technology is high-tech and requires constant research and development. Nowadays hydrometallurgy (extracting and refining metals and minerals with aqueous solutions) is used not just for gold but also for alumina, nickel, copper and zinc. In Australia, that process contributes to mineral industry export earnings of around $15 billion a year.

That's big money and the minerals industry operates with huge costs. Which is why the industry has engaged the AJ Parker CRC for Hydrometallurgy to find ways of reducing operating costs by 2 to 3% a year and to improve safety and environmental effects.

The CRC has responded with programs to find new processes and improve the old, to train newcomers to the industry, and upgrade the expertise of established staff. For example, one new process developed is a way of improving nickel production by oxidising and removing the iron content, while another greatly improves industrial safety with a means of suppressing the acid mist that can rise during the processing of zinc.

The CRC's seminars, workshops and sharing of the latest information with such aids as CD-ROMs have ensured that Australia's minerals industry is right up to the mark—and when so many companies are international, that puts Australia in the forefront and leads to opportunities for the Centre to develop an international market for local expertise.

Clients of the CRC eagerly seek the benefits available from the results of research. Not surprising when a survey in 2001 showed that the outcomes from 15 projects delivered annual savings in excess of $30 million in operating and capital costs.

Hydrometallurgy is not just a big word—it's the key to the future for a big industry.

Australia in Space

CRC for Satellite Systems

It is more than 30 years since Australia launched a satellite of its own but the CRC for Satellite Systems is looking forward to doing it again in 2002. The all-Australian satellite, named FedSat, is nearing completion in Canberra and will be launched from Japan under a bilateral agreement. The mission will usher in a new era in Australian space technology.

The satellite will be relatively small: a cube of just 50 cm, weighing about 58 kg. Despite this small size, it will pack a lot of punch in that it will serve as the platform for a number of high-technology 'payloads'—the instruments carried by the satellite to gather data to support the Centre's research and development projects.

Among the payloads carried by FedSat will be a magnetometer to measure features of the earth's magnetic field related to investigations of space weather; a computer that can be reconfigured in space by reloading software from the ground station; a new means of gathering environmental information through satellite communications; and a global positioning system (GPS) receiver.

The hardware and software for the ground station to be used for telemetry, tracking and control of FedSat was developed largely within Australia and this is one of several features of FedSat which will establish the country as a highly credible provider of space services. Similarly, while CRC engineers needed to work overseas for more than two years to gain the necessary knowledge of platform system and subsystem technologies, they have successfully transferred their know-how to the CRC's industry and research partners so that a truly local expertise has grown.

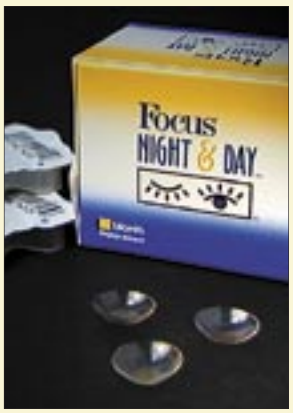
The launch and operation of FedSat will consolidate the CRC's ability to win markets in the Asian region for its technology. The work of the CRC is a prime example of how Australia's technological expertise can lead to commercial expansion.

Award winner

A Long-term Vision

The CRC for Eye Research and Technology

THE COOPERATIVE RESEARCH CENTRE FOR EYE RESEARCH AND TECHNOLOGY



The criticism is sometimes levelled at Australia that its scientists and technologists are very good at inventing but hopeless at getting products to market, so their inventions go overseas and Australia gains little. This criticism can't be directed at the CRC for Eye Research and Technology (CRCERT).

In 1999, CRCERT announced the development of a new kind of contact lens that can be worn continuously for up to 30 days and nights. The lens, made of silicone hydrogel, is highly oxygen permeable, making it safe for overnight wear. Marketed as Focus Night and Day™ by CIBA Vision, the lens is now available in more than 40 countries and is already worn by more than 400,000 people. CRCERT patients who have worn the lenses successfully for 12 months or longer report overwhelming satisfaction, with 93% rating the lenses as excellent. Focus Night and Day™ is the fastest product launched in the history of the contact lens industry to reach US$1 million in sales. In short, it's a world-beater.

The development of the lens was the result of a partnership between the CRC and CIBA Vision, and the CRCERT scientists continue to work closely with the commercial firm in evaluating and further refining the application of their research.

With about 95 million people in the world already wearing contact lenses, the potential market for this Australian invention is enormous. CRCERT receives a royalty from sales which funds future research and education and by 2002 this royalty had returned well over $1 million and is growing extremely rapidly.

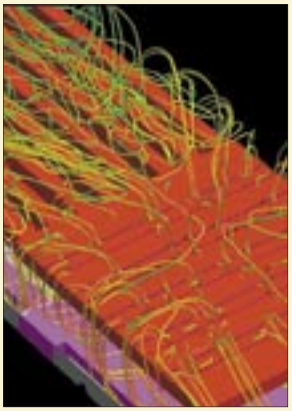
And just for extras, the unique polymers developed for the lens are so likely to prove valuable outside ophthalmics that the CRC and its partners have formed a US-based spin-off company with an investment of over US$10 million to develop and market their further potential.

Computation for Better Bread

CRC for International Food Manufacture and Packaging Science

Bread baking is an ancient technology but in today's world of huge quantities baked commercially for sale in supermarkets, modern technology is needed to improve the product and reduce costs.

When the CRC for International Food Manufacture and Packaging Science first got involved in the art of bread baking, they successfully found ways to make the baking process more efficient and less wasteful. Attention then shifted to what went on in the oven itself. Were ovens the right shape, did they heat economically and uniformly to the right temperatures, and what actually happened to a lump of dough in the process of becoming a loaf?



To answer these questions, the CRC scientists decided to create a model with the use of a complex tool known as computational fluid dynamics (CFD). This was a daring step since CFD is normally used for the automotive and avionics industries and its use in food processing was scarcely known.

In the end, the results were remarkable. To get a model for a commercial oven continuously producing large quantities of bread, some nine million equations were required; but a workable model was produced and has already been used to optimise the operating conditions of a range of commercial ovens. Better bread at a lower cost is a reality.

An important spin-off of the research has been that the CRC can now apply CFD to other aspects of food production. This puts Australia ahead of the field in processing food more efficiently while saving energy and raw materials, as well as reducing waste and the lost productivity associated with making engineering modifications of uncertain outcomes.

Overall these productivity-enhancing CRC technologies have saved food-processing company Goodman Fielder over $1 million to date and have the potential of recouping as much each year for the foreseeable future.

Funeral Bells for a Wedding Weed

The CRC for Australian Weed Management

Brides love a colourful bouquet and it seemed like a great idea 150 years ago when 'bridal creeper' was imported from South Africa. Unfortunately, the aggressive creeper is highly invasive in bushland. Now it's a menace that can smother plants of up to three metres in height and choke big areas of natural forest and mallee.

The CRC for Australian Weed Management started looking for weed management solutions in 1995. With colleagues in South Africa, they searched for natural enemies of the creeper. Three have since been approved safe for release—a leafhopper which eats the creeper's leaves, a beetle which strips the shoots, and a fungal rust which defoliates the plant.

Tests showed that these three agents, which only attack bridal creeper, complement each other and could have quite dramatic effects. The only problem was rearing enough of them to release in high priority areas.

Here, the community was enlisted to help. The CRC ran workshops to teach schoolchildren, Landcare groups, and other community members how to rear and release the leafhoppers. By September 2001, over 100 schools and community groups nationally had grown the leafhoppers and released them at more than 273 sites. Similarly, a scheme to empower community groups to release the rust was developed and it has now been distributed to some 220 sites.

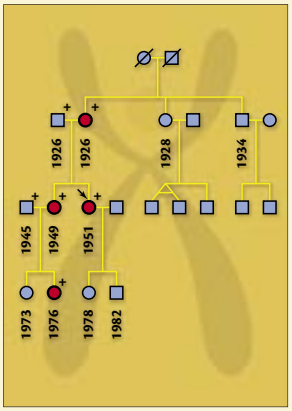
The beauty is that what looked like a major difficulty for the CRC has been overcome by engaging a great many schoolchildren in a practical exercise which has taught them a lot about the environment and how to care for it. They and their teachers have responded with great enthusiasm and the weed is on its way out.

Cooperation against Disease

The CRC for Discovery of Genes for Common Human Diseases

Many thousands of women across the world suffer from a debilitating disease called endometriosis. Very little is known about endometriosis; it can't be prevented, there is as yet no cure for it, but around 40% of women who are infertile suffer from it. It is painful and the pain, even if not continual, tends to keep recurring. Moreover, while there are medicines that can relieve the pain, they often have severe side effects.

A glimmer of hope for tackling this disease came when it was realised that there was probably a substantial genetic ingredient in vulnerability to endometriosis. The hunt was then on to track down the gene or genes responsible.



The CRC for Discovery of Genes for Common Human Diseases (Gene CRC) was well placed to take part in this hunt. A study they did revealed that identical twins were more likely to contract the disease than the non-identical ones—which suggested that the genetic influence was strong.

At the same time, a group at Oxford University reported that the risk factor seemed to be particularly high for women whose sisters suffered from endometriosis. Recently, the Gene CRC and Oxford University have joined forces to undertake a major study involving over 5000 women and their family members from Australia and the United Kingdom.

Thanks to international cooperation, the prospects are bright—it is hoped that a better understanding of the genetics and biology of endometriosis will lead to diagnostic tests to identify those individuals at risk of developing endometriosis and therapies that are able to treat the underlying cause of the disease rather than just the symptoms, leading to better health outcomes. And this is no small matter—in 2001, the global market for endometriosis treatments was conservatively estimated at US$200 to 500 million.

Casting the Die for Innovation

CRC for Cast Metals Manufacturing

What is die-casting? Most people probably have little more than a vague idea of this fundamental industrial process but it is vital to a huge variety of manufacturing operations where metals have to be forced into a metallic mould so as to produce a part of the right shape and dimensions. That is die-casting.

Perhaps the most familiar application of die-casting is to be seen in engine parts—above all in motor cars. In the manufacture of such parts, precision is often of the highest priority and, for the manufacturer, so is the elimination of waste and inefficient operation.

The CRC for Cast Metals Manufacturing (CAST) has established a Die-casting Best Practice Project which provides invaluable support to the industry by the direct transfer of innovative technology. The project aims to help firstly by increasing efficiency by minimising the amount of scrap that is left, reducing the need for reworking, and decreasing the waste of raw materials, energy and labour; secondly by supporting the introduction of new manufacturing technology; and thirdly by improving manufacturing processes.

When a company wants to work on an innovation that it has selected, collaborative teams of CRC and company staff are formed to survey the needs and find ways of meeting them. Beyond this, the CRC promotes developments across the whole industry which have resulted in savings in energy and energy costs and the adoption of better ways of reducing greenhouse gas emissions. In addition, the CRC has developed a die coat that is being tested and promises significant improvements in manufacturing.

In an industry with an annual turnover of more than $400 million, the benefits of innovation derived from this project are being seen both in financial returns and in a new attitude towards best practice.

Instant Information for Tourism

CRC for Sustainable Tourism

Tourism is one of the most diverse industries in Australia. The firms involved in tourism are spread across a number of sectors including transport, hospitality, retailing, accommodation, touring, entertainment and more. In Australia alone, some 120,000 businesses—from small to very large—deliver goods and services to travel and tourism.

For Australia to be one of the world's leading tourist destinations, all of these companies need to be able work together seamlessly—planning and managing their operations using the latest and most integrated sets of up-to-date information. But where is the information to be found?

Part of the answer has emerged from the CRC for Sustainable Tourism, which has now completed the prototype of Decipher® — the name given to a data mining system, which can deliver vital information and business intelligence to Australia's travel and tourism industry. A spin-off company has been formed and is getting ready for the commercialisation of Decipher® and its roll-out across all states and territories.

Decipher® is in effect a 'one-stop shop' where anyone involved in the industry can get straight to the information, which they otherwise would have to hunt for in a veritable jungle of Internet sites, statistical reports, databases and so on.

Decipher® can access multiple data sources including the Australian Bureau of Statistics, Bureau of Tourism Research and the CRC itself, delivering highly detailed information to all sectors of the tourism industry. In addition, the requested information can be manipulated into business reports, graphs, charts and spreadsheets to further assist tourism and travel companies in their daily operations or with future plans. In other words, Decipher® offers accuracy, flexibility and immediate relevance.

Within Australia, Decipher® aims to serve an industry that grosses $71.2 billion a year; and it will soon be ready for launching onto the world market.

Jasjit Baveja

Medical Implant—Killer or Saviour?

CRC for Eye Research and Technology

Almost everyone in the western world can expect to have an implant placed in their body at least once during their life.

This doesn't necessarily mean anything so dramatic as a pacemaker—it could be a simple catheter, a denture or a pair of contact lenses. But whatever it is, there is a risk that it will carry bacteria into your body with it, and that brings the risk of an infection which may be hard to get rid of.

Jasjit Baveja's research involves trying to stop such infection before it happens. Some marine organisms produce compounds, called furanones, which seem to stop bacterial colonisation. These, Jasjit believes, may provide a solution to implant infection—and because they stop the bacteria forming colonies rather than killing them, bacteria do not become resistant to them.

John Heap

A Better Pasture for More Sheep

CRC for Weed Management

When certain herbicides are sprayed onto crops to kill weeds, minute amounts can remain in the soil to devastate pasture plants when the paddocks are used for grazing. The problem is worst in low-rainfall areas such as the Mallee. Medics (clover-like plants) are the preferred pasture there and the herbicide residues can reduce their growth by as much as 90%.

John Heap and his colleagues have used 'mutation breeding' (not gene transfer) to create the necessary resistance and have found that a single selected plant was resistant to a wide range of herbicides. The new medic can grow as much as ten times bigger than normal plants in contaminated soils.

After testing for safety, release of the medic is expected in 2005. If it is successful, the new plant could boost Australian sheep production by $45 million a year.

Megan Hemming

Wilt in Cotton and Bananas? Tomatoes to the Rescue

CRC for Tropical Plant Protection

Australia's cotton and banana industries gross $1.3 billion and $250 million a year respectively; but both plants are susceptible to fusarium wilt, a disease which is hard to control and badly affects production. The tomato, by contrast, is highly resistant to this fungal disease.

Plants can fight off diseases when they possess a resistance gene that acts as a 'switch' to turn on the plant's defences under attack. Perhaps the tomato resistance gene could be transferred to cotton and banana so as to activate their defence mechanisms when fusarium wilt appears.

The research in which Megan Hemming is involved is testing this idea. The first task is to isolate the right gene in tomatoes. So, even if the transfer doesn't work, tomato breeders can use the information about the gene to accelerate the process of producing resistant varieties of tomato.

Justin Zakis

A Hearing Aid that Listens and Learns

CRC for Cochlear Implant and Hearing Aid Innovation

Current studies suggest that up to three of every ten hearing aids fitted world-wide are discarded, and less than one in three are used full-time daily. Reasons for not using hearing aids are partly linked to current fitting methods, where hearing aids are adjusted to suit the 'average' person with a given degree of hearing loss, rather than the 'unique' individual. Further, the adjustment is accomplished in a clinic where the noise environment is different from everyday surroundings experienced by that person.

Justin Zakis has made a prototype in which the user adjusts volume and tone settings and, when judged as optimal for the particular environment, signals the hearing aid to 'memorise' them. The hearing aid then adjusts to these preferred settings automatically when it next experiences that environment.

This breakthrough promises major benefits for many people with impaired hearing and a big expansion of the market for Australian devices.

Andrea Griffin

Teaching Wallabies to be Afraid

CRC for the Conservation and Management of Marsupials

One of the sad tales of European settlement in Australia is the loss of natural species that has followed hunting, the clearing of habitat for farming and development, and the introduction of predators such as foxes and cats.

When species are nearing extinction, efforts to save them may include breeding them in captivity and then releasing them into the wild. Unfortunately, the animals that are released have not learned to fear their predators and readily fall victim to them.

With the help of the Marsupial CRC, Andrea Griffin has found that one of these endangered species—the tammar wallaby—can be taught to fear foxes. Before training, the wallabies simply look at a fox and then start foraging again. The researchers teach the captive-bred tammars to associate the appearance of a fox with being trapped in a net—which they hate—and so learn to run away from foxes and to remain alert.

Jennifer Lowe

Blocked Arteries Kill Industry Too

CRC for Hydrometallurgy

If human arteries can get blocked, so can pipes. And if the pipes in question are the arteries of a $5 billion-a-year export industry, there is a lot at stake.

Jennifer Lowe is taking part in some fundamental research into a deposit called DSP (desilication product) which clogs up pipelines in the alumina industry. Until now, little was known about DSP—exactly what it was and how it formed on a molecular scale. So this research begins at the smallest possible scale: atomic structure.

So far, it has been found that DSP forms by the build-up of small, hill-like structures on pipe walls and that these hill-like features make up a 'wool ball' structure at the sub-millimetre scale. And certain negatively charged ions seem more likely to become locked within the DSP structure and to influence the growth of DSP. This basic research is essential if scale reduction strategies are to advance into the future.

John Sanderson

Size Can Make All the Difference

CRC for Clean Power from Lignite

Burning brown coal in fluidised beds—containers of churning, bubbling, high temperature sand—is one way of using it in an environmentally friendly way. Unfortunately, big, industrialised fluidised beds don't always work in the same way as small test models. And getting it wrong can be very expensive indeed.

The key to predicting what will happen as things get bigger is a principle known as 'scaling laws' and these are what John Sanderson is researching with respect to burning brown coal in fluidised beds.

The chaotic churning of a fluidised bed looked at first to be too complex for any mathematical modelling, but John's research—starting at a small scale and then moving up to much bigger sizes with a combination of plant equipment and laboratory measurement—has shown that scaling laws work when the size of a fluidised bed is increased 1000 times.

Lindsay White

How to Help Fish to Climb

CRC for Catchment Hydrology

Many fish native to Australia, including the huge Murray cod, migrate for long distances as part of their life cycle. The problem is how they are to move upstream if the waterway is cluttered with barriers like weirs and culverts.

In other countries, 'fish ladders' are often used to help salmon to leap upwards but past research has shown that Australian species are not so inclined to jump.

Lindsay White is now investigating the flow patterns of water within 'fishways' in the Murray–Darling Basin and how five species of fish behave in that flow. From there, experiments are being set up within different types of 'fishways' to see which will be most likely to help the fish in their upstream migrations.

A wide range of equipment is being used, including water velocity probes and underwater video cameras, to see whether the fishways really work.

Sodium and Sugar Don't Mix

CRC for Sustainable Sugar Production

Soil that has a high proportion of sodium attached to the clay is bad news for sugar producers. Unfortunately, about 15% of the soil used for sugar-growing in Australia is of this kind, especially in coastal districts. To make it worse, the affected soil often occurs in scattered patches throughout a field, so the problem for the farmer is first to find the sodium-affected soil and then to decide what to do about it.

Until recently, the only way to spot sodicity (as this condition is called) was by testing soil samples in a laboratory. This was both expensive and time-consuming, especially when the farmer could only guess where the bad patches were.

Now the CRC for Sustainable Sugar Production (CRC Sugar) has produced a relatively simple kit that can be used to test for sodicity in the field. So long as farmers have a basic understanding of soils they can soon do the testing themselves, once they have gone through a short training session. The kit contains materials and instructions for three different field tests.

To make sure the benefits were widely disseminated, the CRC trained growers and more than 90 extension and agribusiness staff in the use of the kit so that they in turn could teach the farmers how to use it.

The kit also contains a manual. The best way of dealing with sodium-affected patches is not to grow sugar on them, but in case this is not practical, the manual describes alternative soil amendments that have been successfully tried. A simple computer program calculates how much of each soil amendment to apply, based on the original test.

The extent of sodicity is only gradually being discovered but the CRC estimates that it may be responsible for the loss of as much as 500,000 tonnes of cane a year, worth about $16 million. That's a lot of sugar.

Award winner

At Last, a Viable Substitute for Plastic

CRC for International Food Manufacture and Packaging Science

It's hard today to imagine a world without plastic, but it's so hard to get rid of. If only there were a substitute which had all the advantages of plastic but could be easily and safely disposed of. Well now there is—thanks to Australian scientific and technological know-how.

The plastics industry worldwide has annual sales of about $1000 billion but nobody has added up the cost of trying to dispose of it without polluting the environment. Much of the plastic produced is used for food and drink packaging, so it made sense for the CRC for International Food Manufacture and Packaging Science to look for an alternative. The CRC has been developing a new technology since 1995 and, with the cooperation of five specialised organisations, found ways of using plastics manufacturing systems to produce packaging materials made from biodegradable polymers.

Two kinds of material have been devised. One, which is particularly useful for dry goods, is made from almost pure cornstarch. When it comes in contact with water, it collapses and soon degrades. The other is water-resistant but if you bury it in soil or compost it, it will virtually disappear within four weeks. Yet in many respects both can rival or better the performance of plastics, especially as packaging for food.

The first product has been named the Plantic BioTray D and has already won intense interest from multinational food companies in an industry that has a global market size of around $540 billion. Naturally, there is also huge interest from countries and organisations that are concerned about plastic-caused pollution.

The company formed to commercialise these new plastics from plants, Plantic Technologies Limited, expects sales worth over $2 million in 2003, forecast to rise to more than $200 million by 2006.

The Spark that Led to an Export

CRC for Clean Power from Lignite

Low-cost, accurate chemical analysis of materials and manufactured products is an ongoing challenge for industry.

Since 1997, a research group at the CRC for Clean Power from Lignite has been developing a means of analysing coal quickly, accurately and cheaply for the power industry. The initial result was an instrument called a laser plasma spectrometer. In essence, this instrument uses a laser to induce a bright spark (plasma) at the surface of the material in question. The light from this spark is then analysed by a unique system of spectrometers, detectors and software.

The benefits of using this instrument include the speed at which the analysis can be done, and the fact that—although originally designed for coal—the spectrometer can also be used for a wide range of materials such as minerals and ores, cement and other building materials, metals and alloys, pharmaceuticals, and many substances that need to be analysed in environmental monitoring.

Following prototype development and testing in power stations, a joint venture company, Laser Analysis Technologies (LAT), has been formed to manufacture and market the spectrometer (called the SpectroLaser) worldwide. While the potential global market is enormous, amounting to as much as $500 million a year, LAT's ambitions are more modest, with a sales expectation of $10 million a year within several years. To achieve this, LAT is working with various industries to develop wide applications for the instrument, which was launched in the USA and Europe in the early part of 2002.

So a bright idea led to a spark and triggered a technological innovation that Australia is about to export to the world. And on the home front, the participant companies gain from having constant access to the latest developments, since as the technology is updated, it is immediately installed at the participants' sites.

Savings from Drier Sludge

CRC for Waste Management and Pollution Control

The raw material handled by a sewage treatment plant (STP) usually consists of about 96% water and plant operators separate the water from the solids as far as practical. The water is returned to the rivers or sea and the solids, in the form of 'sludge', are processed for use as fertiliser or compost.

Even so, the sludge still consists of around 85% water, so the cost of storing or transporting it would be much lower if more of that water could be got rid of. In Sydney, for example, the sludge is expensively transported in large trucks from coastal STPs to the western suburbs for treatment.

Various attempts have been made to dry the sludge. One way is heat-drying and another is the use of centrifuges. No method, however, has yet been found that is both cheap enough and fully efficient.

The CRC for Waste Management and Pollution Control was asked to tackle this problem and summoned up its research resources. One possible approach was the use of electric current in de-watering. This method had previously been tried but nobody had managed to apply it to a constant flow of large quantities of sludge.

After much experimentation, building up from small quantities, the CRC developed a successful method with the use of a rolling belt press (to squeeze water out of the sludge) combined with an electrical charge. More research remains to be done on the science underlying the technological application. However, if, as is hoped, the new process can increase the solid content of sludge from 10% to 40%, the savings in transport costs would mean that the system could almost pay for itself in the first year and from then on could yield annual savings of around $5 million.

The Fight Against Tropical Plant Disease

CRC for Tropical Plant Protection

Northern Australia is often pictured as a lush, tropical environment where plants and fruits grow easily and in abundance. But the same climate encourages the rapid growth of a wide variety of plant diseases, some of which can be remarkably difficult to diagnose and manage.

Disease has no respect for state boundaries, but a mix of state and federal agencies take responsibility for research, detection and management of disease problems; universities, CSIRO and state agricultural departments conduct research into the detection and management of disease; and Commonwealth and state departments have their own interests in fighting destructive pests and diseases—for example, quarantine is an important function of the Commonwealth Government.

With so many agencies involved, coordination of effort and exchange of information becomes a major challenge. As a result, these bodies have combined in strong support of a major initiative of the CRC for Tropical Plant Protection—the creation of a Northern Australian Diagnostics Network (NADN) to pool the resources of all the participating bodies.

The NADN takes advantage of new technologies to improve the detection and management of threats to the commercially valuable plants in northern Australia and to the natural environment. As new information becomes available it is not only widely shared, but delivered in the right form to be of practical use to the diagnostician, the quarantine officer or the farmer.

Already the NADN has proved its worth. A test for a disease known as 'black sigatoka' in bananas has been made available and is expected to save over $21 million a year in losses from, and management of, this disease. It is also estimated that a technology for diagnosing the serious fungal disease *Phytophthora* (dieback) will save the horticulture industry up to $30 million a year, depending on its rate of adoption.

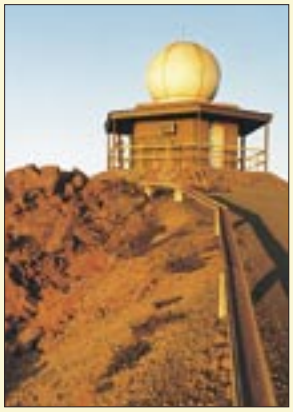
Let's Talk about the Weather

CRC for Catchment Hydrology

Managing water resources better, reducing pollution, and ensuring that everyone has clean water to drink are all responsibilities that various levels of government take very seriously, even if most of us take them for granted.

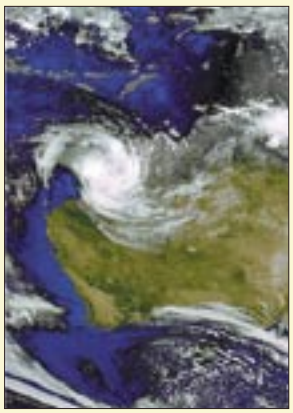
Authorities constantly need accurate and up-to-the-minute information on when, where and how much rain is falling or about to fall, and for this the research of the CRC for Catchment Hydrology, in conjunction with the Bureau of Meteorology's nationwide radar network, is producing impressive results.

The CRC's innovative work into climate variability enables more accurate predictions to be made of the precise level and location of rainfall during storms—something which has obvious benefits for water management, including getting ready for floods.



Concrete examples of the usefulness of CRC research include helping Sydney Water to overhaul its sewerage system and, in the process, save around $20 million over the next 20 years. In Victoria, Melbourne Water is now able to anticipate the results of heavy storms on its sewer network and catchment areas; and everywhere organisers of major sporting fixtures can take defensive measures against the threat of bad weather now that they can more readily find out if it is about to hit them.

All this and much more has resulted from the CRC's pioneering approach of bringing together hydrologists, climate modellers, weather forecasters and researchers from various disciplines to seek answers to some of the world's most complex weather forecasting questions, one of the big ones being exactly when and where a storm is about to strike.



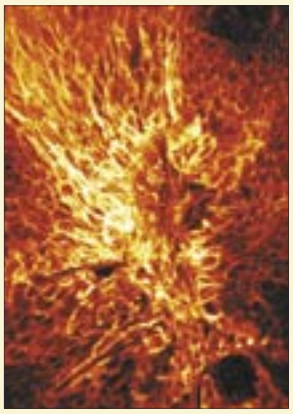
The short-term detailed forecasting system, which the CRC calls 'nowcasting', is already being implemented across Australia, and weather forecasters in other countries are eager to use this Australian innovation.

A lot of the guesswork has been taken out of talking about the weather.

Award winner

From Research to the Pharmacy

CRC for Tissue Growth and Repair



In a relatively small country like Australia, research into biotechnology has for the most part to be carried out in public-sector institutions such as universities, CSIRO or specialised research institutes. The difficulty then is to get the results from the research scientist's bench into the pharmaceutical company's sales list.

Traditionally, universities have simply licensed multinational companies to use their technology; but that means that most of the value is lost overseas and the original research organisations in Australia get only a small return through royalties.

The CRC for Tissue Growth and Repair is tackling this problem of technology transfer by spawning new Australian biotechnology companies, with the ultimate aim of transforming the CRC itself into a self-sustaining commercial company.

So far, three new companies have been set up. GroPep Ltd, set up to license technologies jointly developed by Adelaide University and CSIRO, is now a thriving enterprise with sales of $9.6 million in 2000/2001; Primegro focuses on biotechnology for veterinary purposes and has had an impressive effect on the pig industry; and TGR BioSciences Pty Ltd aims to continue the commercialisation of intellectual property for the CRC's partners when the CRC itself unwinds.

Self-sufficiency within the biotechnology research field is the first aim and the formation of spin-off companies shows how this can successfully be achieved. The final goal is to retain for Australia a much bigger slice of the returns from its success in research.

This, in turn, means more funds for research which needs long periods for development and may require as much as $500 million to develop a single drug.

Lift Less and Do More

CRC for Mining Technology and Equipment

Often the response to a brilliant but simple idea is: why didn't we think of that before? The Universal Dig & Dump (UDD) dragline, an innovation developed by the CRC for Mining Technology and Equipment, has engineers throughout the world pondering that question.

Open-cut mines mainly rely on massive machines known as draglines to shift dirt around the mine. But every time a dragline lifts its bucket, it also lifts some 20 tonnes of heavy rigging. And this rigging constrains what the dragline can do.

The brilliant idea? Attach the dragline's hoist and dump ropes to the bucket in a different way, giving the operator precise control over the angle of the bucket. Then—and this is a very clever trick—design a control system that will semi-automatically adjust the carry angle of the bucket for digging, carrying or dumping.

The UDD system uses 13 tonnes less rigging (so the dragline can lift more dirt) and allows a dragline to perform operations that were previously impossible. As a result, a UDD dragline is as much as 30% more productive (worth some $15 million of revenue a year to a mine with one dragline).

After trials with a one-tenth scale model, the CRC proved that the new technology would work on the real thing. BHP Billiton Mitsubishi Alliance (BMA) retrofitted one of its draglines with the technology this year. Although switching over was a massive and expensive exercise, BMA is confident that the UDD will pay for itself many times over. BMA's chief executive has been quoted by the *Mining Journal of London* as saying that installing UDD on all of the company's draglines would reduce operating costs by one third or increase coal output by 10 million tonnes each year (at a third of the cost of a new mine).

Getting to Grips with the Grape

CRC for Viticulture

The huge growth of the wine industry, both in size and value, has been one of the most exciting developments in Australian agriculture over the last 40 years. Our wines regularly win international prizes and their market share is expanding, both at home and overseas.

Wine-growers are always looking for ways to improve the quality of their vintage since they have a vision of an expansive future and a 25-year plan to succeed in the global wine business. This means that they need speedy access to the latest technological developments but this is hindered by two factors: wine-growing is widely spread across the nation; and expert technical staff tend to move around a lot within the industry.

The CRC for Viticulture has instituted a system for countering these disadvantages with what is proving to be a highly popular and successful series of training courses under the title of Research to Practice® Viticulture. This began with training in pest management, but over the past five years it has expanded into a national program covering key aspects of grape and wine industry innovation.

The program is carried out through intensive, interactive two-day workshops run across all the grape-growing areas of Australia. Experts on topics of local relevance present research information that is intensively discussed; and towards the end of the course, each participant nominates at least one change to be implemented in their own vineyard over the next season.

The program now offers five 'packages' covering grapevine nutrition, spray application in viticulture, integrated pest management, water management, and wine grape quality management.

The result of the program is the rapid development of industry-wide best practice which is delivering substantial cost–benefit advantages to the viticulturists and an even better product for the world's wine-lovers.

Grapes for the World's Tables

CRC for International Food Manufacture and Packaging Science

Australian grapes are not only used to make this country's internationally popular wines; our table grapes also have shares of the world and home markets. But there is a problem with the packaging used to keep the grapes free of botrytis rot—a fungal disease that destroys their value if infected. The current packaging, while doing its job, also tends to bleach the grapes and can leave residues unsuitable for asthmatics.

The growers regularly have their product reduced in value because of this bleaching, so they approached the CRC for International Food Manufacture and Packaging Science and asked them to look for a solution.

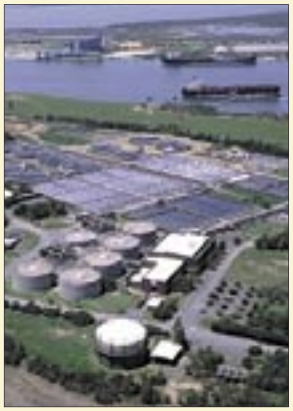
Botrytis rot can be prevented in stored grapes by weekly applications of sulphur dioxide (SO_2), but this has proven difficult to achieve during transport. The CRC has solved the problem by developing a grape-packaging bag that has an inner lining with built-in controlled-release polymers compounded with an SO_2-emitting agent. When the grapes are put into boxes lined with these bags, the inner lining slowly and uniformly releases low levels of SO_2 that stops the rot yet avoids the bleaching and residues.

The CRC has obtained a patent for this technology and is now undertaking field trials and initial market development while awaiting full registration. The liner bags will then be available for sale throughout Australia, and an international launch is planned for the 2003 season.

Not only will growers then be able to transport their grapes in packaging that will preserve the quality and appearance of the fruit, the innovative lining is itself expected to be highly marketable in all grape-producing countries. The world market for export grape packaging is over $400 million and the CRC is confident that its technology is capable of replacing at least 20% of this through selection of its commercialisation partners.

Keeping an Eye on Moreton Bay

CRC for Coastal Zone Estuary and Waterway Management



The land, rivers, bay and sea of Moreton Bay provide nearly two million people with one of Queensland's most attractive environments, but it will only remain attractive if it is well protected.

Councils and industry in the region have implemented numerous protection measures such as improved treatment plants, stormwater controls and waste-water management. These measures have public support and are vigorously applied, but do they work? And what happens when unforeseen events take place?

The CRC for Coastal Zone, Estuary and Waterway Management, for the Moreton Bay Waterways and Catchments Partnership, has a team of scientists who continually check the environmental health of the region. And then—to make sure that the public and all the relevant authorities are aware of what is happening—each year a 'report card' is issued which assesses each of eight regions for their environmental performance. In 2001, scores ranged from A– (a fraction under 'excellent') to F for 'fail'.

The report card is available to the public and is given to councils, government departments, community groups and private industry, all of whom are both affected by the results and to some extent responsible for them.

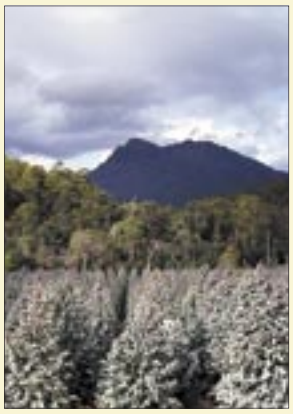
The scientists gather physical, chemical and biological information from more than 400 sites. This is analysed by interdisciplinary teams and interpreted in maps and charts that show where and why threats to the Moreton Bay environment have arisen. These may be as diverse as poor health of seagrass to storm floods dumping sediment and nutrients into the Bay.

The report cards give everyone the latest information on how well the protection measures are working and how they need to be improved. Consequently, not only the CRC and its partners but the whole population bordering one of Queensland's most important coastal areas are involved in protecting it.

Research with and for Forestry

CRC for Sustainable Production Forestry

Tasmanian blue gum (*Eucalyptus globulus*) is a fast-growing Australian tree that is widely grown around the world. If a grower can plant trees with dense wood and fast growth, then more return can be expected from each hectare of plantation.



The CRC for Sustainable Production Forestry researchers constantly seek ways in which this kind of improvement can be achieved. The CRC works in close cooperation with the Southern Tree Breeding Association (STBA) so that research results can be evaluated and the results promptly applied in the field. Most eucalypt growers in southern Australia belong to the STBA and 80% of STBA's eucalypt members are partners in the CRC, so technological advances can be quickly disseminated for practical use.

Economic models developed by the CRC have been incorporated into the breeding strategies of the STBA and genetic analyses for finding the best trees to propagate. These models enabled growers to boost the gain from selecting the right seeds by 14%, which means an improvement of $2 million a year over the old method which accorded equal importance to each selection trait.

One such trait, wood density, can be improved now that the CRC has shown that assessing wood density by shooting a steel pin into the tree is better than selecting for growth alone—to the tune of $300 per hectare or $6 million a year for the industry—and the figure goes even higher if density is assessed by coring.

These and other techniques, such as better breeding strategies and a quicker and more effective means of pollinating, have all contributed to extra growth and better products which help to make the forestry industry ever more profitable.

CRC Association Members

Manufacturing Technology

CRC for Advanced Composite Structures
CEO: Dr Ian Mair
PHONE: 03 9646 6544 • FACSIMILE: 03 9646 8352
EMAIL: crc-acs@duigen.dsto.defence.gov.au
WEB: http://www.crc-acs.com.au

CRC for Bioproducts
CEO: Dr Doug Hawley
PHONE: 03 9706 9730 • FACSIMILE: 03 9706 8936
EMAIL: dhawley@hellaylabs.com.au
WEB: http://www.botany.unimelb.edu.au/CRC.html

CRC for CAST Metals Manufacturing
CEO: Professor David St John
PHONE: 07 3365 3574 • FACSIMILE: 07 3365 3888
EMAIL: cast@cast.crc.org.au
WEB: http://www.cast.crc.org.au

CRC for Construction Innovation
CEO: Professor Keith Hampson
PHONE: 07 3864 2288 • FACSIMILE: 07 3864 9151
EMAIL: k.hampson@construction-innovation.info
WEB: http://www.construction-innovation.info

CRC for Functional Communication Surfaces
CEO: Mr Rod Urquhart
PHONE: 03 9905 3456 • FACSIMILE: 03 9905 3413
EMAIL: rod.urquhart@eng.monash.edu.au

CRC for Intelligent Manufacturing Systems and Technologies
CEO: Mr David Galvin
PHONE: 03 9480 0400 • FACSIMILE: 03 9480 0413
EMAIL: info@crcimst.com.au
WEB: http://www.crcimst.com.au

CRC for International Food Manufacture and Packaging Science (finished)
CEO: Dr Roger Edwards
PHONE: 03 9214 8124 • FACSIMILE: 03 9818 8531
EMAIL: REdwards@foodpack.crc.org.au
WEB: http://www.foodpack.crc.org.au

CRC for Microtechnology
CEO: Dr Clive Davenport
PHONE: 03 9214 8557 • FACSIMILE: 03 9214 8008
EMAIL: info@microtechnologycrc.com
WEB: http://www.microtechnologycrc.com

CRC for Polymers
CEO: Dr Ian Dagley
PHONE: 03 9558 8111 • FACSIMILE: 03 9558 8122
EMAIL: polymers@crcp.com.au
WEB: http://www.crcp.com.au

CRC for Railway Engineering and Technologies
CEO: Mr Dudley Roach
PHONE: 07 4930 9597 • FACSIMILE: 07 4930 6984
EMAIL: d.roach@cqu.edu.au
WEB: http://www.crcrail.com.au

CRC for Welded Structures
CEO: Dr Colin Chipperfield
PHONE: 02 4226 8889 • FACSIMILE: 02 4226 9841
EMAIL: colin_chipperfield@uow.edu.au
WEB: http://www.crcws.com.au

CRC for Wood Innovations
CEO: Professor Peter Vinden
PHONE: 03 8344 5250 • FACSIMILE: 03 9349 4172
EMAIL: pvinden@ unimelb.edu.au

Information and Communication Technology

Australian Telecommunications CRC
CEO: Dr Leith Campbell
PHONE: 08 9266 3432 • FACSIMILE: 08 9266 3244
EMAIL: info@atcrc.com
WEB: http://www.atcrc.com

CRC for Enterprise Distributed Systems Technology
CEO: Mr Mark Gibson
PHONE: 07 3365 4310 • FACSIMILE: 07 3365 4311
EMAIL: m.gibson@dstc.edu.au
WEB: http://www.dstc.edu.au

Australian Photonics CRC
CEO: Professor Mark Sceats
PHONE: 02 9351 1901 (switch) • FACSIMILE: 02 9351 1910
EMAIL: info@photonics.crc.org.au
WEB: http://www.photonics.com.au

CRC for Satellite Systems
CEO: Dr Brian Embleton
PHONE: 02 6216 7270 • FACSIMILE: 02 6216 7272
EMAIL: satsys@crcss.csiro.au
WEB: http://www.crcss.csiro.au

CRC for Sensor Signal and Information Processing
CEO: Professor Don Sinnott
PHONE: 08 8302 3942 • FACSIMILE: 08 8302 3124
EMAIL: info@cssip.edu.au
WEB: http://www.cssip.edu.au

CRC for Smart Internet Technologies
CEO: Dr Jeffrey Tobias
PHONE: 02 8374 5080 • FACSIMILE: 02 8374 5090
EMAIL: jeffrey.tobias@smartinternet.com.au
WEB: www.smartinternet.com.au

CRC for Technology Enabled Capital Markets
CEO: Professor Michael Aitken
PHONE: 02 9299 1883 • FACSIMILE: 02 9299 1830
EMAIL: mai@smarts.com.au
WEB: www.finance.econ.usyd.edu.au (Finance, U Syd)
WEB: www.sirca.org.au (Securities Industry Research Centre)

Mining and Energy

AJ Parker CRC for Hydrometallurgy
CEO: Mr Mark Woffenden
PHONE: 08 9360 2552 • FACSIMILE: 08 9310 8481
EMAIL: hydrocrc@central.murdoch.edu.au
WEB: http://www.parkercentre.crc.org.au

Australian CRC for Renewable Energy Ltd
MANAGING DIRECTOR: Dr Frank Reid
PHONE: 08 9360 6620 • FACSIMILE: 08 9360 6624
EMAIL: freid@acreltd.murdoch.edu.au
WEB: http://acre.murdoch.edu.au

Australian Petroleum CRC
CEO: Dr Peter Cook, CBE
PHONE: 02 6200 3366 • FACSIMILE: 02 6230 0448
EMAIL: pjcook@apcrc.com.au
WEB: http://www.apcrc.com.au

CRC for Clean Power from Lignite
CEO: Dr David Brockway
PHONE: 03 8542 0800 • FACSIMILE: 03 9561 0710
EMAIL: reception@cleanpower.com.au
WEB: http://www.cleanpower.com.au

CRC for Coal in Sustainable Development
CEO: Mr Frank van Schagen
PHONE: 07 3871 4400 • FACSIMILE: 07 3871 4444
EMAIL: Frank.vanSchagen@ccsd.biz
WEB: http://www.ccsd.biz

CRC for Landscape Environments and Mineral Exploration
ACTING CEO: Mr Paul Wilkes
PHONE: 08 6436 8695 • FACSIMILE: 08 6436 8560
EMAIL: Susan.Game@csiro.au
WEB: http://leme.anu.edu.au

Centre for Mining Technology and Equipment
CEO: Dr Michael Hood
PHONE: 07 3346 2521 • FACSIMILE: 07 3346 2523
EMAIL: info@cmte.org.au
WEB: http://www.cmte.org.au

CRC for Predictive Mineral Discovery
CEO: Dr Robert Haydon
PHONE: 03 8344 6514 • FACSIMILE: 03 8344 7761
EMAIL: b.allen@unimelb.edu.au

Agriculture and Rural Based Manufacturing

CRC for Australian Cotton
CEO: Dr Gary Fitt
PHONE: 02 6799 1500 • FACSIMILE: 02 6799 1186
EMAIL: Gary.Fitt@csiro.au
WEB: http://www.cotton.crc.org.au

CRC for Australian Sheep Industry
CEO: Professor James Rowe
PHONE: 02 6776 1465 • FACSIMILE: 02 6776 1334
EMAIL: jrowe@metz.une.edu.au

CRC for Cattle and Beef Quality
CEO: Professor Bernie Bindon
PHONE: 02 6773 3501 • FACSIMILE: 02 6773 3500
EMAIL: beefcrc@metz.une.edu.au
WEB: http://www.beef.crc.org.au

CRC for Innovative Dairy Products
CEO: Dr Paul Donnelly
PHONE: 03 9607 8607 • FACSIMILE: 03 960 2044
EMAIL: paul.donnelly@dairycrc.com

CRC for Molecular Plant Breeding
CEO: Dr Bryan Whan
PHONE: 08 8303 6539 • FACSIMILE: 08 8303 6789
EMAIL: crcmpb@waite.adelaide.edu.au
WEB: http://www.molecularplantbreeding.com

CRC for Sustainable Aquaculture of Fin Fish
CEO: Dr Peter Montague
PHONE: 08 8290 2302 • FACSIMILE: 08 8200 2481
EMAIL: Peter.Montague@aquafincrc.com.au
WEB: www.aquafincrc.com.au

CRC for Sustainable Production Forestry
CEO: Professor Rod Griffin
PHONE: 03 6226 7947 • FACSIMILE: 03 6226 7942
EMAIL: CRCForestry@ffp.csiro.au
WEB: http://www.forestry.crc.org.au

CRC for Sustainable Rice Production
CEO: Dr Laurie Lewin
PHONE: 02 6951 2713 • FACSIMILE: 02 6951 2533
EMAIL: crc.rice@agric.nsw.gov.au
WEB: http://www.ricecrc.org

CRC for Sustainable Sugar Production
CEO: Professor Robert Lawn
PHONE: 07 4781 5763 • FACSIMILE: 07 4781 5506
EMAIL: crcsugar@ jcu.edu.au
WEB: http://www-sugar.jcu.edu.au

CRC for Tropical Plant Protection
CEO: Professor John Irwin
ACTING CEO: Dr Ian Muirhead (2002)
PHONE: 07 3365 2790 • FACSIMILE: 07 3365 4771
EMAIL: ceo@tpp.uq.edu.au
WEB: http://www.tpp.uq.edu.au

CRC for Value Added Wheat
CEO: Dr Bill Rathmell
PHONE: 02 9490 8488 • FACSIMILE: 02 9490 8503
EMAIL: hwarwick@wheatcrc.com.au
WEB: http://www.wheat-research.com.au

CRC for Viticulture
CEO: Dr Jim Hardie
PHONE: 08 8303 9405 • FACSIMILE: 08 8303 9449
EMAIL: crcv@saugov.sa.gov.au
WEB: http://www.crcv.com.au

Environment

CRC for Antarctica and the Southern Ocean
CEO: Professor W.F. Budd
PHONE: 03 6226 7867/2971 (PA IASOS) • FACSIMILE: 03 6226 2973
EMAIL: secretary@antcrc.utas.edu.au
WEB: http://www.antcrc.utas.edu.au

CRC for Australian Weed Management
CEO: Associate Professor Richard Roush
PHONE: 08 8303 6590 • FACSIMILE: 08 8303 7125
EMAIL: rick.roush@adelaide.edu.au
WEB: http://www.waite.adelaide.edu.au/CRCWMS

CRC for Biological Control of Pest Animals
CEO: Dr Tony Peacock
PHONE: 02 6242 1768 • FACSIMILE: 02 6242 1511
EMAIL: office@pestanimal.crc.org.au
WEB: http://www.pestanimal.crc.org.au

CRC for Catchment Hydrology
CEO: Professor Rob Vertessy
PHONE: 02 6246 5746 • FACSIMILE: 02 6246 5845
EMAIL: rob.vertessy@csiro.au
WEB: http://www.catchment.crc.org.au

CRC for Coastal Zone, Estuary and Waterway Management
CEO: Dr Roger Shaw
PHONE: 07 3362 9398 • FACSIMILE: 07 3362 9379
EMAIL: roger.shaw@dnr.qld.gov.au
WEB: http://www.coastal.crc.org.au

CRC for Conservation and Management of Marsupials
CEO: Professor John Rodger
PHONE: 02 9850 9251 • FACSIMILE: 02 9850 9254
EMAIL: jrodger@possum.bio.mq.edu.au
WEB: http://www.marsupialcrc.com.au

CRC for Freshwater Ecology
CEO: Professor Gary Jones
PHONE: 02 6201 5168 • FACSIMILE: 02 6201 5038
EMAIL: gjones@enterprise.canberra.edu.au
WEB: http://freshwater.canberra.edu.au

CRC for the Great Barrier Reef World Heritage Area
CEO: Professor Russell Reichelt
PHONE: 07 4729 8400 • FACSIMILE: 07 4729 8499
EMAIL: info@crcreef.com
WEB: http://www.reef.crc.org.au

CRC for Greenhouse Accounting
CEO: Dr Chris Mitchell
PHONE: 02 6215 4020 • FACSIMILE: 02 6215 5095
EMAIL: chris.mitchell@greenhouse.crc.org.au
WEB: www.greenhouse.crc.org.au

CRC for Plant-based Management of Dryland Salinity
CEO: Professor Philip Cocks
PHONE: 08 9380 2555 • FACSIMILE: 08 9380 1140
EMAIL: pcocks@agric.uwa.edu.au
WEB: www.crcsalinity.com

CRC for Sustainable Tourism
CEO: Professor Terry De Lacy
PHONE: 07 5552 8116 • FACSIMILE: 07 5594 8171
EMAIL: info@crctourism.com.au
WEB: http://www.crctourism.com.au

CRC for Tropical Rainforest Ecology and Management
CEO: Professor Nigel Stork
PHONE: 07 4042 1246 • FACSIMILE: 07 4042 1247
EMAIL: rainforestcrc@jcu.edu.au
WEB: http://www.rainforest-crc.jcu.edu.au

CRC for Tropical Savannas Management
CEO: Professor Gordon Duff
PHONE: 08 8946 6834 • FACSIMILE: 08 8946 7107
EMAIL: savanna@ntu.edu.au
WEB: http://savanna.ntu.edu.au

CRC for Waste Management and Pollution Control Ltd
CEO: Dr David Garman
PHONE: 02 9385 4886 • FACSIMILE: 02 9662 1971
EMAIL: crcwmpc@unsw.edu.au
WEB: http://www.crcwmpc.com.au

CRC for Water Quality and Treatment
CEO: Professor Don Bursill
PHONE: 08 8259 0351 • FACSIMILE: 08 8259 0228
EMAIL: crc@sawater.sa.gov.au
WEB: http://www.waterquality.crc.org.au

Medical Science and Technology

CRC for Aboriginal and Tropical Health
CEO: Professor Tony Barnes
PHONE: 08 8922 8473 • FACSIMILE: 08 8927 5187
EMAIL: debra@menzies.edu.au
WEB: http://www.ath.crc.org.au

CRC for Asthma
CEO: Mr Philip Bert
PHONE: 02 9515 6417 • FACSIMILE: 02 9550 5865
EMAIL: philipb@mail.med.usyd.edu.au
WEB: http://www.asthma.crc.org.au

CRC for Cellular Growth Factors
CEO: Dr John Flack
PHONE: 03 9345 2559 • FACSIMILE: 03 9345 2616
EMAIL: crccgf@wehi.edu.au
WEB: http://www.ludwig.edu.au/crc-cgf

CRC for Chronic Inflammatory Diseases
CEO: Professor John Hamilton
PHONE: 03 8344 6252 • FACSIMILE: 03 9347 1863
EMAIL: jahami@unimelb.edu.au

CRC for Cochlear Implant and Hearing Aid Innovation
CEO: Dr Robert Cowan
PHONE: 03 9667 7508 • FACSIMILE: 03 9667 7518
EMAIL: m.chapman@medoto.unimelb.edu.au
WEB: http://www.bionicear.com.au/crc

CRC for Diagnostics
CEO: Professor Ian Gardner
PHONE: 07 3864 4015 • FACSIMILE: 07 3864 1534
EMAIL: i.gardner@qut.com
WEB: http://diagnosticsCRC.org

CRC for Discovery of Genes for Common Human Diseases
CEO: Dr Andrea Douglas
PHONE: 03 9208 4444 • FACSIMILE: 03 9208 4030
EMAIL: genecrc@cerylid.com.au
WEB: http://www.genecrc.org

CRC for Eye Research and Technology
CEO: Professor Brien Holden
PHONE: 02 9385 7418 • FACSIMILE: 02 9385 7401
EMAIL: crcert@crcert.unsw.edu.au
WEB: http://www.crcert.org

CRC for Tissue Growth and Repair (winding up as a CRC, continuing as a TGR Biosciences Ltd)
MANAGING DIRECTOR: Professor Leanna Read
PHONE: 08 8354 6171 • FACSIMILE: 08 8354 6188
EMAIL: leanna.read@tgr-biosciences.com.au
WEB: http://www.crc-tgr.edu.au

CRC for Vaccine Technology
CEO: Professor Anne Kelso
PHONE: 07 3362 0430 • FACSIMILE: 07 3362 0104
EMAIL: CRCVT@qimr.edu.au
WEB: http://www.crc-vt.qimr.edu.au

Published by:

Cooperative Research Centres Association, Inc.

RSISE Building
Cnr North and Daley Roads
The Australian National University
Canberra ACT 0200

Telephone: 02 6125 8835
Facsimile: 02 6125 8836
Email: crca@crca.asn.au
Web: <http://www.crca.asn.au>

CRC Program Administration:

CRC Program
Science Programs Branch
Department of Education, Science and Training

Level 4, 16 Mort Street
GPO Box 9880
CANBERRA CITY ACT 2601

Telephone: 02 6240 5011
Facsimile: 02 6240 9096
Web: <http://www.crc.gov.au>

Writing and design by Clarus Design