Winning new ways for Australia

Underpinning economic growth

Recent highlights of the Cooperative Research Centres Program 2004

CRC ASSOCIATION

CRC AUSTRALIA

Manufacturing Technology

Information and Communication Technology

Mining and Energy

Agriculture and Rural Based Manufacturing

Environment

Medical Science and Technology

Foreword

Cooperative Research Centres (CRCs) are an integral part of the Australian innovation system. The success stories featured in this booklet are from applicants for the 2004 CRC Association's Awards for Excellence in Innovation. Each applicant is a superb demonstration of why the Australian Government supports the CRC Program to promote long-term strategic collaboration between researchers and research users.

This booklet not only highlights the success of partnerships and cooperation in research and development, it showcases successful commercialisation of research by CRCs and the establishment of innovative education programs.

This year, there was a record number of applications for the awards, highlighting the strength of the CRC Program. The four winners were presented with awards by former Science Minister, the Hon Peter McGauran, MP, at the Association's annual conference in June.

Also featured are presentations made by CRC students at the conference. CRCs continue to provide world-class opportunities for students to engage in cutting-edge research.

There are now 69 CRCs, sharing about $193 million of CRC Program funding in 2004–05. Funding for the program was increased under *Backing Australia's Ability — Building our Future through Science and Innovation*. An extra $65 million is being provided over 6 years, demonstrating a commitment to CRC selection rounds in 2006 and 2008, as well as the current 2004 round. This extra funding builds on the $62.5 million of additional funding provided in the 2003–04 budget. The CRC Program has never had such a long-term funding commitment.

The CRCs featured here represent all six sectors of CRC research: Information and Communication Technology; Medical Science and Technology; Environment; Mining and Energy; Agriculture and Rural Based Manufacturing; and Manufacturing Technology. This demonstrates the diversity of CRCs and the substantial contribution that they make to many areas of importance to Australia.

I warmly congratulate them on their efforts.

Dr Brendan Nelson MP
Minister for Education, Science and Training
November 2004

Winners

CRC FOR POLYMERS

Award for innovation arising from the application and utilisation of research

Hon Peter McGauran, MP, previous Minister for Science

Mr Andew Stobart, Managing Director, Olex Australia Pty Ltd

Dr Ian Dagley, CEO, CRC for Polymers

Hon Tony Staley, Chairman, CRC Association

CRC FOR AUSTRALIAN WEED MANAGEMENT

Award for innovation in education, training and public outreach activities

Hon Tony Staley, Chairman, CRC Association

Dr Rachel McFadyen, CEO, CRC for Australian Weed Management

Ms Rae Kwong, Victorian Department of Primary Industries, Frankston

Ms Vicki Hawker, South Australian Animal and Plant Control Commission

Hon Peter McGauran, MP, previous Minister for Science

CRCMining

Award for innovation arising from the application and utilisation of research

Hon Tony Staley, Chairman, CRC Association

Mr Cam Davidson, Project Manager, Universal Dig and Dump System, BHP Billiton Mitsubishi Alliance

Emeritus Professor Don Nicklin, Chairman, CRCMining

Hon Peter McGauran, MP, previous Minister for Science

CRC FOR CAST METALS MANUFACTURING

Award for innovation arising from the application and utilisation of research

Hon Peter McGauran, MP, previous Minister for Science

Professor David StJohn, CEO, CRC for Cast Metals Manufacturing

Dr Malcolm Frost, General Manager, Technology and Environment, Australian Magnesium Corporation

Hon Tony Staley, Chairman, CRC Association

Contents

Introduction

Welcome to highlights of the CRC program for 2004. The stories in this booklet are based on the applications for the Awards for Excellence in Innovation given at the annual CRC Association Conference. They are divided into two categories — *Application and utilisation of research* and *Education, training and public outreach activities* — and emphasise not only the CRCs' aim to produce world-class outcomes for direct application, but also our ongoing dedication to education, not only for training purposes but also for contributing to the uptake and use of CRC research. In judging the Awards, one of the key criteria of which the judges take note is the extent of cooperation between researchers/educators and the users of the research/education — the essence of the CRC program.

It was a tough choice in the research utilisation category, and hence we awarded three prizes: to the ***CRC for Cast Metals Manufacturing*** for identifying a low-cost and environmentally friendly gas for magnesium processing that could revolutionise the industry; to ***CRCMining*** for significantly lowering the cost of open-cut mining with their 'Dig and Dump' technology; and to the ***CRC for Polymers*** for their ingenious ceramifying plastic for protecting electrical cables from fire. This year's winner in the education category was an innovative project by the ***CRC for Australian Weed Management*** in which school groups help fight invasive weeds by growing and releasing biological control agents. In addition, we have stories about:

- radically improving telecommunications provision with breakthrough optical fibre technology and remote maintenance
- reducing the guesswork in both searching for gold, selecting the best soils for rice-growing, and assessing cattle for feed efficiency
- utilising waste plastic to reduce coal usage in making iron and so in the amount sent to landfill
- protecting investors from stock-market fraud and the Australian banana industry from exotic diseases
- conveniently providing precise data to grape-growers to optimise their valuable grape harvest, and to rowers and their coaches to evaluate their sporting achievement
- using the Internet to exchange information to enable cooperative management in such diverse fields as bushfire management in northern Australia and patient health outcomes
- monitoring fish populations in the Great Barrier Reef and identifying 'bioregions' to make sure the Reef is properly protected and enlisting tourists to help monitor coral health
- increasing public knowledge of the significance of estuaries and providing tools for citizens to get involved in coastal decision-making
- developing a regional resource plan for the Fitzroy Basin in the tropics
- using distance education for high-level training of students in such specialised areas as the light metals industry and railway signalling — this allows both students and their teachers to be in diverse locations
- educating farmers to better manage insect pests in their cotton crops; to choose plants that will help with salinity management; as well as how to eradicate foxes in Tasmania
- educating professionals on contact lens and cochlear implant provision.

We are most grateful to CSIRO for their sponsorship, once again, of *Showcasing of CRC PhD students* at the CRCA conference — this support covered the students' travel, accommodation and conference fees. The Showcasing session aims to encourage their ability to communicate effectively about science in everyday language in order to engage the interest of the wider public. Eight students out of 35 applicants were selected to present their work. This year's winning student, ***Bart Buhre***, is working to protect the environment with his project on coal emissions. The breadth of experience offered in the training of post-graduates in a CRC makes them more in tune with industry needs and opens job opportunities.

We are grateful to those who have given generously of their time to help with the judging.

The judging panel for the Awards for Excellence in Innovation, which I chaired, included:

- Dr Ian Pitman, former Co-chair, CRC Life Sciences Panel
- Professor Leon Mann, Professorial Fellow, School of Behavioural Science, University of Melbourne
- Mr John Marshall, former Co-chair, CRC Physical Sciences Panel
- Dr Laurence Stonehouse, Vice-president Technology & ABS, Alcoa World Alumina and Chemicals
- Dr John Zillman, AO, FTSE, President, Australian Academy of Technological Sciences and Engineering.

For the Showcasing of CRC PhD Students, the judges were:

- Dr John Boyd, consultant, previously General Manager, CRC Program
- Mr Toss Gascoigne, President, Australian Science Communicators
- Dr Sue Stocklmayer, Director, Centre for Public Awareness of Science, Australian National University
- Dr Geoffrey Vaughan, Chair, CRC Committee
- Mr Graham Walker, Smart Moves Program at Questacon and Australian Science Festival.

All of the projects described in this booklet are *Winning new ways for Australia* and underpinning significant economic growth which will benefit the current and future generations of Australians as well as cementing our reputation overseas as a force in technological ingenuity and education innovation. We hope you enjoy reading about them.

Contact details are given at the end of the booklet for current CRCA members, or visit our website at <http://www.crca.asn.au>.

Hon Tony Staley
Chairman
CRC Association

World communication

Australian Photonics CRC

Whenever data or voice messages are sent to a distant country, odds are that the information is sent through a filter device called the fibre Bragg grating. This has been made in Australia for the past eight years and its function is to filter multiple wavelengths of light within optical fibres, so that huge amounts of information can be transmitted across vast distances.

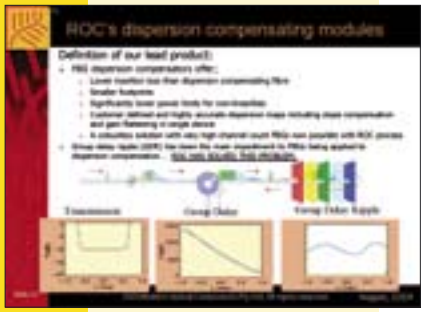
Australia's home of the fibre Bragg grating is Redfern Optical Components Pty Ltd (ROC), a spin-off company of the Australian Photonics CRC. From the start, the fibre Bragg grating was recognised as the way to go for improving transmission by optical fibre, but as demand grows for ever-more capacity in the transmission systems, the challenge has been for ROC to develop even more sophisticated fibre Bragg gratings to meet that demand.

Redfern Optical Component's answer was a breakthrough technology that they have called *DirectRite*™ which effectively allows a whole band of channels to be treated with a single fibre Bragg grating structure. They are shipping qualified product that treats all channels used in optical fibre telecommunications.

At present, long-haul and inter-exchange networks have a capacity of from 2.5 to 10 Gigabytes per second (Gbps). The rate of 10 Gbps is rapidly becoming the industry standard around the world. Not only can the ROC technology handle this, but it also substantially reduces the cost of upgrading networks to that rate. In the future, systems are expected to have a capacity of 40 Gbps, and for that the ROC *Direct Rite*™ will be essential.

The ROC's Fibre Bragg Gratings are currently being sold in a non-telecommunications markets worth US$2–3 billion, plus niche markets for other optical fibre applications which are worth about US$1.5 billion. And that is just for starters. The ROC products have yet to tackle the telecommunications components market, and the value of this is estimated at some US$1 billion.

The CRC's spin-off company, Redfern Optical Components, produces a range of fibre Bragg gratings set to triumph in the telecommunications components market.



Right soil for rice

CRC for Sustainable Rice Production

Rice is a big crop in Australia, with virtually all of it grown in the Murrumbidgee and Murray irrigation areas of southern New South Wales. While very valuable to the economy, rice crops use 60–70% of the irrigation water diverted annually to these regions and have contributed to watertable rise and secondary salinisation — primarily because rice has to be grown under submerged conditions.

In the 1990s, NSW Agriculture (now called NSW Department of Primary Industries) set about instituting a management program to reduce these problems; both for rice-growers and producers of other important crops. Channels, drains and recycling systems could all help to make water use more efficient and minimise the rise of the watertables, but more was needed. The missing factor was knowledge of the right soil for growing rice.

Because rice is grown in ponds, it is most effectively grown in soils with low drainage characteristics, such as high clay content. Researchers developed an innovative system using electromagnetic induction instruments to assist in identifying soils most suitable for this purpose. This system has been widely adopted throughout the region with great success.

The CRC for Sustainable Rice Production has further improved this technique by recognising that some soils were being unfairly excluded from rice-growing because another factor in soil permeability was being overlooked — sodicity (sodium level). As soil sodicity increases, drainage generally decreases. Now the CRC has introduced the sodicity factor into the soil-surveying process to produce a hierarchical assessment of soil suitable for rice-growing.

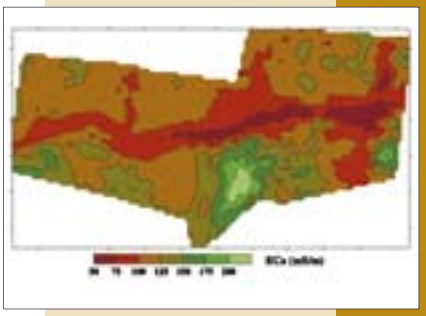
Many farming situations have been revolutionised by the use of this process to assist farm planning and irrigation design. The technique is also being used in decisions for siting farm dams and irrigation channels.

Now rice can be grown in the right places and make efficient use of irrigation water — a valuable advance for an industry with an annual return of around $800 million.

Top: Brian Dunn (NSW DPI) surveying a field with electromagnetic induction (EM) equipment fitted with a global positioning system.

Middle: Map of a rice paddock showing soil variability, including areas of suspected high infiltration (in red).

Bottom: Brian Dunn demonstrating sodicity modifications to the EM technique to irrigation company representatives.



Distant switching

CRC for microTechnology

Existing switching technology: manual operation.

A common sight in Australia's streets is that of a technician crouching before a telecommunications post and fiddling with a bewildering array of terminals and wires. Because the vast majority of telephones are connected to the exchange through copper wires, whenever a line is connected, disconnected or doubled up, the technician has to make the adjustments by hand. This is expensive because it requires a large number of technicians to be on the road, sometimes to very remote locations, and it also means delays for the customer.

The CRC for microTechnology sought a way of making such switching possible at a distance — from an exchange or network centre — and so eliminating the need for technicians to make the connections one at a time.

The microtechnology exists for such switching in other applications but to be useful without replacing the whole of the enormous telecommunications infrastructure, what was needed was a switching device which was big enough to avoid electrical shorts (which would cause telephonic chaos) but small and cheap to manufacture.

After formidable initial difficulties, the researchers solved the problem with the use of printed circuit boards, which are very cheap to make and already manufactured in Australia. The twist was to design them in three dimensions, so that they could make the physical connections between copper wires.

The CRC has joined with Alcatel to patent this invention and various accompanying innovations that improve control of the switches and allow them to actuate the relays. To test whether they will work, several hundred sample arrays have been produced in a pilot facility at CSIRO.

Once installed, the new technology will effect major economies by allowing connections to be changed in seconds rather than hours, and lines to be tested from a distance and faults located.

Fish for the future

CRC for the Great Barrier Reef World Heritage Area

Fish swimming among the corals of the Great Barrier Reef are important to tourists as well as recreational and commercial fishers. They also form a critical part of the reef ecosystem.

Tourism in the Great Barrier Reef catchment is estimated to be worth $4.2 billion a year, with the value of commercial fishing estimated at $200 million a year. There are also more than 800,000 recreational anglers in Queensland, many of them fishing in Reef waters, who spend $240 million each year to catch fish. Accurate information about the fish that are targeted by fishers is critical to ensure that fish stocks are carefully managed.

The fisheries team from the CRC for the Great Barrier Reef World Heritage Area (CRC Reef) has been making detailed studies of fish biology and ecology, as well as the socioeconomics of reef fisheries. These studies provide managers, industry, and anglers with accurate information that is being used to ensure that fish stocks on the Reef, including those species most vulnerable to fishing, are protected for the future.

One of the important studies by CRC Reef is *The Effects of Line Fishing* experiment, which is unique in the world. It will run for 10 years, until 2006, and span 2000 kilometres along the length of the Reef. The researchers have made some surprising discoveries about the life cycles and habits of fish that are already being used to better manage reef fish. For example, studies of reproduction have helped managers set appropriate minimum size limits so that many fish are able to spawn at least once before being caught.

With collaboration between at least seven organisations, the Reef project will ensure fish for the future. Active engagement of all stakeholders at all stages of CRC Reef's research is the key to the success of the work.

Top: Researchers from the CRC Reef examining fish specimens.

Middle: Commercial fishing on the Great Barrier Reef contributes $200 million a year to the national economy.

Bottom: Recreational fishing is an important aspect of reef-based tourism.

Photo: CRC Reef

Photo: CRC Reef

Photo: A. Tobin

Bugs against bugs

Australian Cotton CRC

Natural enemies of cotton pests — such as the big-eyed bug (top), pale night-stalker spider (middle, eating a pest mirid), and red-and-blue beetle (bottom) — help prevent pest outbreaks, thereby reducing insecticide use.

The Australian cotton industry seems to face an unending battle against pests and diseases that could destroy or seriously devalue its crops. In the past, the solution has usually been to use broad-spectrum insecticides, but this carries risks.

Often the insects become immune to the insecticides and new ones have to be found, and the chemicals used can contaminate the atmosphere or waterways. The research of the Australian Cotton CRC, together with growers and agronomic consultants, has shown that there is an alternative to spraying broad-spectrum insecticides to protect cotton. Nature is already helping.

Many cotton pests have natural enemies in other insects and spiders, but with broad-spectrum insecticides, these predators and parasites get destroyed as well. This allows other pests, not affected by the insecticide, to increase unchecked, leading to further expensive control costs. The problem for cotton-growers was understanding which insecticides provided effective pest control and what effect they had on the beneficial insects.

After ten years of research by the Australian Cotton CRC and its predecessor, the CRC for Sustainable Cotton Production, an insecticide-usage guide for farmers has been produced by the CRC, with input from agronomic consultants and growers. Now, if producers need to control insect pests, they can use the guide to pick an insecticide that will target the pest but have little or no effect on the 'good' insects.

Thanks to this guide, use of selective insecticides has increased from 20% to 60%, with far fewer broad-spectrum ones being used. The guide forms a core component of an integrated pest management system for cotton, which has helped reduce the quantity of chemicals applied to cotton crops by about 70% and has been worth over $300 million in reduced costs.

This is good news for the environment as well as for the nation's exports and the 1500 enterprises that grow cotton in Australia.

Plastics for iron

CRC for Coal in Sustainable Development

The industrial revolution was built on coal and one of the industries that still relies heavily on it is ironmaking. The way coal is used in blast furnaces has changed enormously over the past century, but with the need to reduce greenhouse gas emissions, ironmakers everywhere are looking for new ways to reduce their use of coal.

The modern method of using coal is to grind it to a powder and 'inject' it into the furnace. If a substitute fuel can be found which results in lower emissions of greenhouse gases and other pollutants, coal may be increasingly replaced as the fuel of choice.

Some ironmakers have seized on the coincidence that another world problem is that of disposing of immense quantities of plastics. Some forms of plastic may be burnt as ash-free fuel at high temperatures with reduced greenhouse gas emissions. Of course, other plastics can't be burnt without producing noxious fumes.

In Japan and places in Europe, plastics are already being injected along with coal in the blast furnaces, but the cost is regarded as too high in countries where plastics can be disposed of as landfill.

In Australia, The CRC for Coal in Sustainable Development has recently completed a pilot study to research ways in which plastics could be injected together with coal. Naturally, any method adopted would also have to meet the accepted standards for the production of iron and not cause more problems than it solved.

The project has shown that co-firing coal with some plastics produces a more efficient reaction. If the injection of plastic can replace even 10% of the coal burnt, the amount of plastic at present sent to landfill sites could be reduced in Australia by as much as 75,000 tonnes per year.

Professor Veena Sahajwalla has been involved with developing the technology for co-firing plastics with coal (top). Our high use of plastic containers (middle) contributes to mountains of rubbish at landfills (bottom) which could be reduced if plastics are incorporated into coal firing of blast furnaces.

All about estuaries

Coastal CRC

CRC for Coastal Zone, Estuary and Waterway Management

Top: Melaleuca wetland in south-eastern Queensland — esturine habitats such as this provide ecosystem services to the whole community.

Bottom: A near-pristine estuary on Fraser Island in south-eastern Queensland.

Photo: Jan Tilden, Coastal CRC

Photo: Queensland EPA

Although Australia has more than 1000 estuaries, 783 of which are regarded as important ones, most people take them for granted and have little knowledge of their significance to the nation's environment, recreation and tourism — or even as part of the landscape.

To place estuaries more firmly in the national consciousness and help in their preservation and proper management, the CRC for Coastal Zone, Estuary and Waterway Management has put together the Australian Estuaries Package.

This has three key components. One is the OzEstuaries website <www.ozestuaries.org>, which brings together a vast quantity of information, including maps of more than 700 estuaries, planning tools to help manage coastal natural resources, and a simple estuarine response model (SERM) which allows the user to predict the consequences of various human activities on estuaries. The Coastal CRC has also developed a National Estuaries Network that enables scientists, planners and managers to share information and discuss common problems.

Finally, a popular book has been produced. Its title is *Where river meets sea: exploring Australia's estuaries*. It not only takes the reader on a fascinating tour of the continent's estuaries but also shows what factors affect their health, how estuaries function, what pressures they face, and how they feature in the commercial, recreational and cultural life of people who live on or near them.

An innovative aspect of the Australian Estuaries Package is that it integrates diverse management tools, training opportunities and educational services so that science and management can combine for a better future for these important elements in the nation's geography. And as each hectare of an Australian estuary is worth about $41,000 per year in its services to the community, they are extremely valuable assets that need to be well-managed and protected.

Protecting the integrity of capital markets

Capital Markets CRC

Almost daily, the media reports allegations of dishonest trading in securities, the most obvious being insider trading and market manipulation. One reason for this is that market observers consistently focus attention on market efficiency. Little work has been done on ensuring markets are fair. To reduce the cost of capital for Australian businesses, it is essential that Australia's capital markets be both efficient *and* fair. Capital Markets CRC (CMCRC) develops systems that reduce the opportunity for manipulative or otherwise illegal trading.

If investors believe that their money is not safe because capital markets can be manipulated, their distrust will result in a shortage of capital (and higher costs) for the multitude of activities that make a society prosperous.

Since the early 1990s, one of the CRC's main partners — SMARTS Pty Ltd <www.smarts-systems.com> — has sold stock-market fraud-detection systems that now operate in 14 national stock exchanges and four national regulators around the world. Working from the premise that brokers need to protect their own interests, and using the expertise of SMARTS' engineers and developers, CMCRC has now produced a market compliance system — Compliance Explorer — for brokers and other financial intermediaries. It monitors security trading for 39 different types of securities fraud, including trader- and client-level alerts.

Launched in June 2003, Compliance Explorer already monitors more than 80% of Australian market transactions and this year will incorporate options and futures markets. Compliance Explorer will then be the first system in the world that offers real-time cross-market surveillance for an entire marketplace. A spin-off company, which owns the licensing for the product (Capital Markets Surveillance Services Pty Ltd), has been formed with research staff and students participating in an incentive program linked to the project's profitability.

Thanks to the CMCRC's association with industry partner, SMARTS, the new system is also being welcomed by several international exchanges, further benefiting the Australian economy.

Compliance Explorer — the first system in the world to offer simultaneous, real-time cross-market surveillance.

Universal Dig and Dump (UDD)

Winner

The Universal Dig and Dump system in action at a mine in central Queensland.

Draglines are the workhorses of open-cut coal mines and in Australia they typically move 13 million cubic metres of dirt each year, uncovering approximately $75 million worth of coal.

The rigging on a conventional dragline weighs 20 tonnes and has not changed in design in 100 years. This conventional rigging system limits the flexibility of the dragline operation and makes bucket control difficult. As well as high productivity costs when a dragline is out of action for rigging maintenance, there are also substantial safety hazards associated with replacing heavy pieces of equipment.

A new technology developed by CRCMining — the Universal Dig and Dump — replaces conventional rigging with a lighter, innovative configuration, improving operational flexibility. A medium-size Universal Dig and Dump can move up to 13 tonnes more dirt in each pass and a specially designed computer system provides precise control over the bucket, enabling the dragline to dig and dump anywhere under the boom.

The benefits of this new technology were initially demonstrated by CRCMining using a one-tenth scale machine. Subsequently, one of the CRC's industry partners, BHP Billiton Mitsubishi Alliance (BMA), installed the technology on a full-scale dragline and productivity improvements of between 15% and 27% have been demonstrated, depending on the operating conditions of the mine. Three of BMA's draglines have now been converted to the new rigging system, with others in the fleet set to follow.

In Australia alone, this technology is significant. Coal is the nation's major export product, accounting for more than $12 billion last year. BMA, Australia's largest coal-mining company, operates 33 draglines in eight open-cut mines in central Queensland. These mines produce 45 million tonnes of coal a year, which earns more than $3.5 billion in export revenue.

Good news for grapes

CRC for microTechnology

CRC for microTechnology

Grape-growers keep an especially keen eye out for two things: the weather and the soil. The weather not only affects the plants and the fruit but can also warn of frosts and the likelihood of onset of various diseases. The condition of the soil is of great importance for the production of high-quality grapes, especially wine grapes.

Until now, most growers have used expensive equipment to help schedule their irrigation and to supplement weather forecasts. Unfortunately, despite the expense, the results have not been as successful as growers would like. Often large areas are sprayed for disease when only a small area really needed it, and since soil condition is only monitored in a few spots, irrigation water can be wasted in other places.

Now the CRC for microTechnology, in conjunction with Motorola Australia, is developing a new system. Working with the Victorian Department of Primary Industries and their *Botrytis* models, a field trial conducted by the CRC in a Yarra Valley vineyard has produced very promising results.

The new system consists of two inventions. The first, a weather station on a chip, integrates small sensors that can measure wind speed and direction, temperature, light and humidity. The sensors communicate with each other and with a central point by radio and the accumulated data go by a GSM (mobile phone) network to a central point to be interpreted. The details are then sent to the grower.

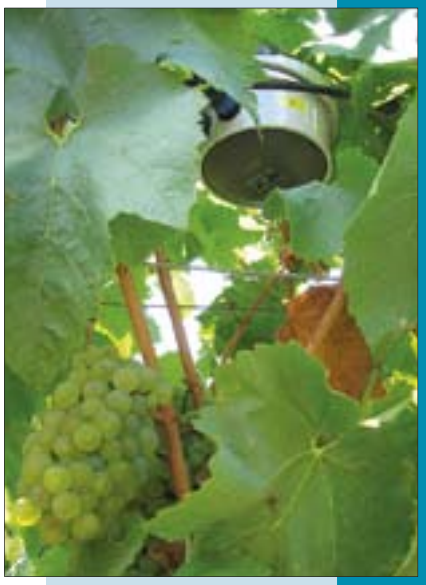
The soil moisture is monitored with sensor modules buried at various depths. These are cheap and flexible and their readings are also connected to the weather sensors, as are other sensors that monitor leaf wetness.

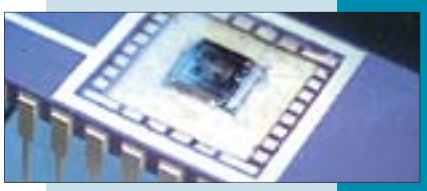
Put all these together and the grower has important information needed for effectively managing the vineyard. Best of all, the system costs far less than previous monitoring systems, and allows more sensing points for real precision agriculture.

Top: Technology on trial in a Yarra Valley vineyard.

Middle: Weather station on a chip.

Bottom: Low-cost soil moisture sensor.





A blanket for magnesium

CRC for Cast Metals Manufacturing

Winner

Top: AM-cover is important in the production of magnesium ingots.

Middle: AM-cover in use during small-scale magnesium sand casting trials.

Bottom: Crucible containing magnesium melt under the invisible protection of AM-cover.

Nowadays magnesium is increasingly being used to make motor vehicle components. Magnesium is lightweight, so using it makes vehicles lighter, hence reducing fuel consumption and greenhouse gas emissions.

However, processing magnesium can be a major source of greenhouse gases. When magnesium is melted, the molten metal tends to oxidise and burn. The solution to this has been to 'cover' it during processing with sulfur hexafluoride (SF_6), which acts as a kind of blanket. SF_6 prevents oxidation but it is the most potent greenhouse gas known.

The CRC for Cast Metals Manufacturing and its industry partner Australian Magnesium Corporation (AMC) have been searching for a replacement for SF_6 — first by examining why SF_6 works as such an effective 'blanket'; then looking for a less harmful gas with similar characteristics for the same price or less. After much trial and error, it was found that a gas known as HFC-134a was the one to go for. Now a way has been found to use it effectively and the method is being promoted across the world under the name 'AM-cover'.

This is an important step for the control of greenhouse gas emissions, as the magnesium industry is increasing throughout the world — 13% a year in die-casting operations alone — and the world production of magnesium is set to increase from the current rate of 415,000 tonnes a year.

The global magnesium industry is currently responsible for 4% of all SF_6 usage and so the advent of AM-cover is a significant innovation, providing the magnesium industry with a safe and more environmentally friendly 'blanket' that is cheap and easy to use. If most magnesium melters in the world switched to AM-cover, the reduction in greenhouse gases would be like eliminating the emissions from a million cars. Already the technology has been licensed for use by eight companies around the world.

Protecting more of the Reef

CRC for the Great Barrier Reef World Heritage Area

The Great Barrier Reef (GBR) attracts about 1.6 million tourists every year and contributes $4.2 billion to the gross value of production in the Great Barrier Reef catchment. Fishing also adds about $200 million to the regional economies along the Reef coastline. These industries depend on a healthy ecosystem for sustainable success.

The GBR Marine Park Authority allows and manages these regulated commercial and recreational uses while at the same time protecting and conserving biodiversity. However, scientists and managers were concerned that more of the Park needed to be completely protected to maintain some of the lesser-known or less-spectacular habitats for the benefit of future generations.

But how should increased protection proceed? The GBR Marine Park Authority recruited the services of more than 70 leading scientists, most of whom were from the CRC for the GBR World Heritage Area (CRC Reef), who pooled their expertise to define 70 'bioregions' within the Park — each area containing plant and animal communities that distinguish it from surrounding areas.

Then the enormous amount of information that had been gathered about the Reef's bioregions was compiled and analysed with the use of a range of software, some of which had been specifically developed for the purpose by researchers from CRC Reef.

Finally, after two phases of community consultation, the Australian Government re-zoned the Marine Park, with the proportion of marine sanctuaries ('no-take' zones) increasing from 5% to 33%. The re-zoning is the largest and most comprehensive marine planning process ever undertaken anywhere in the world.

The new plan, based on sound scientific advice provided by CRC Reef, will ensure the future of the Great Barrier Reef, which is the largest coral reef ecosystem that has ever existed. And ensure that private anglers and commercial fishers will still be able to catch their fish for a long time to come.

Life in the Great Barrier Reef: a diver encounters a school of tropical fish (top); a sea anemone (middle); and a coral trout (bottom).

Photo: CRC Reef

Photo: P. Nangle

Photo: D. Wachenfeld

Spot the fires

CRC for Tropical Savannas Management

Top: Frequent fires are degrading some northern Australian landscapes.

Middle: Management of bushfires in northern Australia often requires deliberate burn-off to reduce fuel and create firebreaks.

Bottom: In Arnhem Land, Aboriginal Traditional Owners Otto Campion and Dean Yibarbuk and a Bushfires Council officer examine maps of fire scars produced on the website.

Stretching right across northern Australia, from the Indian Ocean to the Pacific, are the tropical savannas — immense areas of grassland, lightly wooded plains and woodlands. Since most Australians live in the south of the continent, it may surprise many to learn that these savannas are the most frequently burnt region of Australia.

Sometimes the fires are deliberately lit for a variety of management purposes; sometimes they are caused by lightning and other natural events. Whatever the cause, the pastoral property owners and the Indigenous communities of Western Australia, the Northern Territory and Queensland have a vital interest in coping with fire and taking effective precautions when wild fires break out.

The bodies and individuals involved in managing fire are widely separated and have never found it easy to know where the fires are and to pass on information about them. Now, through cooperation between the CRC for Tropical Savannas Management and other interested parties, outback bushfires that are tracked from space by satellites can be mapped and seen on a website <www.firenorth.org.au> within hours of their being detected. Constant feedback from fire managers on the 'front line' allows the researchers and web developers to produce a tool that meets their daily requirements.

Because it is a cooperative website, the fire-mapping accuracy can be readily tested and the researchers can make changes that are appropriate and practical. In this way, everybody has a stake in the exchange of accurate and relevant information.

It has been estimated that effective fire management is worth, on average, $75,000 a year to a typical cattle property in northern Australia; and the website helps those responsible to limit the damaging effects of wild fires on animals and sensitive plants throughout the region. Spotting and mapping the fires has become an essential service to northern Australia.

Fireproof plastic

Winner

Imagine a major hospital fire. All the electric cables are destroyed, life-saving machinery stops working, the operating theatre is blacked out... One can imagine similar scenes with fires in factories, control rooms, tunnels and so on. This is why manufacturers protect electrical cables from fire by wrapping them in mineral-filled glass tape before applying layers of insulation and sheathing.

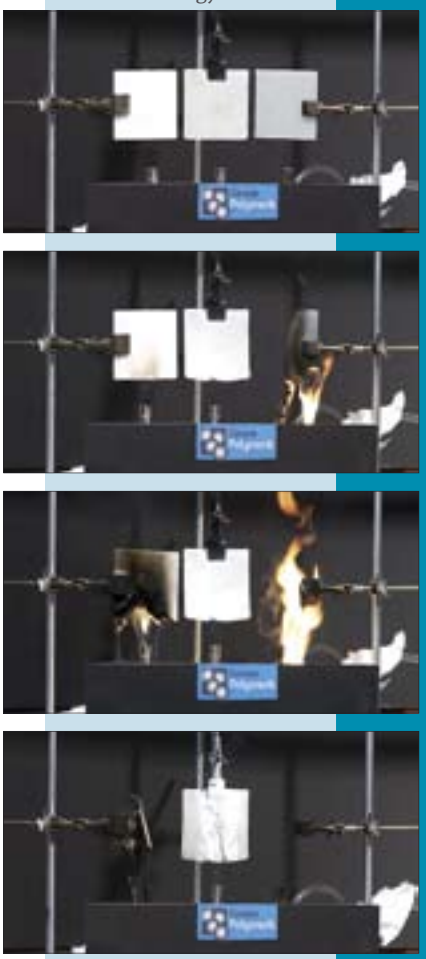
Australian standards require such cables to keep operating when heated in a furnace for two hours to 1050°C and then subjected to a water jet spray for three minutes. These exacting standards have so far ruled out the kind of plastic wrapping we are used to in domestic appliance cables. But the problem with the glass tape is that it is expensive and results in a cable that is very stiff and difficult to install or join.

Now the CRC for Polymers has overcome these problems with a new plastic that can be applied as an insulation layer for cables. This has the remarkable property that when subjected to intense heat, it doesn't melt and collapse — instead, it hardens into a ceramic barrier that resists the fire and allows the cable to stay operative. And, of course, it is much simpler and cheaper to extrude plastic over a cable than to wrap tape around it.

The CRC for Polymers, in conjunction with Olex, Australia's biggest maker of power cables, intended only to make a plastic insulation layer for electrical cables but in succeeding in this they also produced a technology that can be applied readily to other polymers.

The research culminated in the launch, in July 2003, of the Pyrolex Ceramifiable™ range of cables from Olex. Over the next five years, sales of the new cables are expected to generate revenue of at least $75 million.

Exposure of test panels of fire-retardant polypropylene (left), ceramifying polymer (centre) and polyethylene (right) demonstrates the excellent fire-barrier properties and shape retention achieved with the CRC's technology.



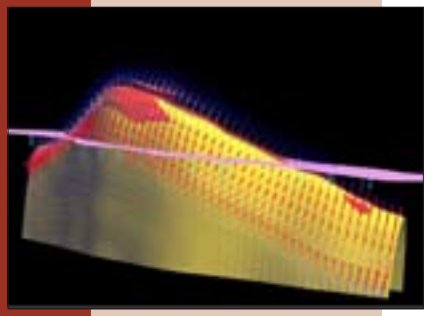
Go for gold!

CRC for Predictive Mineral Discovery

Top: Close collaboration between researchers and research users has been fundamental to the success of the project.

Middle: 3D geometry of a basalt dome with modelled shear strain (red shapes), fluid flow vectors (arrows) and the current erosion level (purple surface).

Bottom: Exploring under cover is a bit like looking for a needle in a haystack, blindfolded!



After the nineteenth century gold rush, the gold in Victoria finally ran out — almost. First the prospectors and then the mining companies extracted the precious metal from mines that were relatively shallow and these were eventually exhausted.

Of course, the mining companies would like to find more gold, but where are they to look? Gold isn't spread over the countryside like grass — it ends up where it is because of complex movements over millennia in the Earth's crust. So it's reasonable to suppose that where gold has been found, there may be more.

Until recently, one of the most common ways to search for gold (or other minerals) was to drill into the earth in a grid pattern over a broad target area and hope to find something. But this involved an element of expensive guesswork and often yielded small or no results. In particular, it was difficult to know how deep to drill.

Now the CRC for Predictive Mineral Discovery, in conjunction with sponsor company MPI Mines Ltd, has applied modern science and technology to the search. In western Victoria, where MPI Mines Ltd have an operating gold mine, the geologists used the existing mine data and new modelling technology to 'draw' a three-dimensional geological picture of the Earth's crust in that area. From that, they were able to conclude where the gold would most likely have been deposited and were able to apply this knowledge to the search for new gold deposits in a more regional context.

The results have been promising: instead of wasting time and money on relatively random drilling, MPI Mines Ltd has been able to drill in several defined sites through the thick layers of sediment down to gold-bearing rock.

This predictive method of minerals exploration bears promise for other minerals too in an industry that is forecast to earn Australia $58.3 billion in 2004–5.

Healthy catchments

Coastal CRC

CRC for Coastal Zone, Estuary and Waterway Management

The Fitzroy Basin in central Queensland is home to many industries, including grazing, cropping, irrigation, mining, ports and tourism. With such a diversity of activities comes a risk that polluting sediments and nutrients may be washed down the waterways into the coastal zone and the Great Barrier Reef lagoon.

To help develop a regional resource plan, as required by the Australian Government's National Action Plan for Salinity and Water Quality (NAPSWQ), the Fitzroy Basin Association (FBA) partnered with the CRC for Coastal Zone, Estuary and Waterway Management. This partnership is a working model of the CRC's mission to bridge gaps between science and the community.

In 2003, the Coastal CRC team compiled information on the natural resources of the Fitzroy region, making available reliable science on such diverse matters as water quality, ecology, the effect of land management practices on the region's waterways, and the relationship of local communities to their coastal environments — all presented in a way that makes sense to the many people involved in the planning process. The resulting document, published in print and CD-ROM formats, has helped the FBA consult communities thoughout the vast Fitzroy Basin and develop targets for managing the region's natural resources.

In addition, public awareness has been raised in the region by a two-year television campaign on *Healthy Waterways*.

As the lifeblood of one of Australia's largest catchments, the Fitzroy River has national economic significance. By developing a plan to improve and protect its water quality, the Coastal CRC, FBA and other stakeholders are protecting central Queensland's assets, such as agricultural land, fisheries, biological diversity and, ultimately, the southern section of the Great Barrier Reef.

A framework devised by the Coastal CRC to organise the vast amount of material presented in the information paper has now been adopted by the Queensland Government to provide resource information to other NAPSWQ regions, emphasising the success of the approach taken by the CRC.

Top: This barrage on the Fiztroy Estuary, built to limit the upstream movement of the tide, has changed the natural flow of the river.

Middle: Sediment from the Fitzroy and its catchment are carried far from the coast, especially during the floods.

Bottom: Saltwater crocodiles in the Fitzroy have elevated levels of pesticides in their eggs. Improving water quality will help this population survive.

Photo: Bob Packett

Photo: Australian Centre for Remote Sensing

Photo: Bob Packett

Keeping the record straight

CRC for Enterprise Distributed Systems Technology

Most people realise the importance of their personal health records, but they may be patients of numerous health-care professionals — general practitioners, specialists, dentists, physiotherapists, pharmacists, hospitals and so on — each of whom keeps separate records. Ignorance of a patient's medical history can lead to errors in treatment, as well as wasting time in asking patients the same questions repeatedly.

It seems obvious that records should be available to whoever is treating you at any given time, but if you can't remember the details, how will the health-care professional access your history? And if it *is* available, how do you know that it's safe from people who have no right to it?

In addition to poor patient health outcomes, the absence of shared health records can be costly to the health service, insurers and others. In the USA, it has been estimated that if the exchange of health information could be standardised, it would save US$87 billion a year.

In response to these concerns, the CRC for Enterprise Distributed Systems Technology (trading as DSTC) has been researching ways to handle scattered health information held in a variety of formats and to make it possible for health practitioners to access this information when necessary — with the patient's permission.

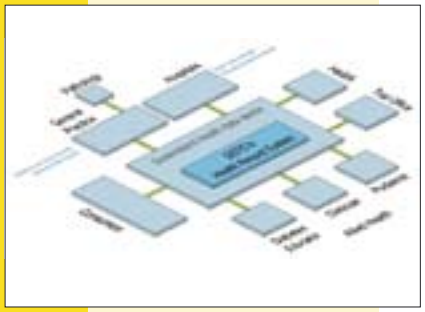
The electronic health record (EHR) system they have invented is based on *open*EHR (an open and international EHR initiative) and is being tested as part of the development of Australia's national electronic health record network, Health*Connect*.

Health*Connect* involves the collection, storage and exchange of consumer health information via a secure network and within strict privacy safeguards to provide better integration of care and improved outcomes across the health care system. Consumers' health information will be collected in the form of standardised event summaries enabling health care professionals to access information generated by different user systems, whilst ensuring the privacy of the consumer.

Top: Paul Harvey (Dept of Health and Ageing), Karen Gibson (QLD Health), Andrew Goodchild (DTSC) and Robert Lippiatt (DSTC).

Middle: System overview of the Brisbane Southside Health*Connect* trial.

Bottom: DTSC's EHR solution on display at the Health Informatics Conference (HIC 2004).



Beefing them up

CRC for Cattle and Beef Quality

Beef-growers' highest cost is providing feed for their cattle. So it's important that the feed gets results. But sometimes the animal in question is a 'poor doer', as they say. Cattle breeders and farmers have long known that some cattle are better disposed genetically to make the best use of the feed they get.

Now, research under the auspices of the CRC for Cattle and Beef Quality (Beef CRC) has confirmed genetic variation exists in feed efficiency, measured as net feed intake. Genetic differences in this simple measure of whether an animal eats more or less than expected for its size means that, by selective breeding, offspring can be produced which are the most efficient eaters — resulting in lower feed costs and improved profitability.

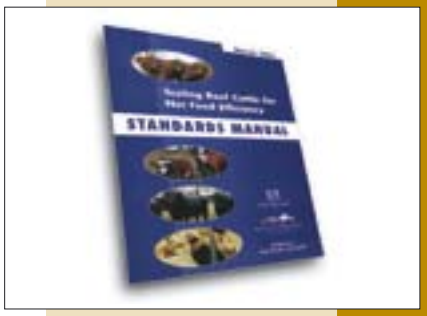
Cattle breeders have been able to assess the genetic merit of one bull against another by comparing estimated breeding values produced in Australia by the Animal Breeding and Genetics Unit at the University of New England, including one for net feed intake. However, the expensive three-month test needed to determine the feed efficiency of a young bull meant that only a few hundred bulls were tested each year, instead of the thousands that the industry needs to expand the prospects of breeding for feed efficiency.

The final piece in the jigsaw which allowed farmers to 'beef up' efficiency came with a new blood test developed by the Beef CRC and its partners. It is a much less expensive way to produce estimated breeding values for net feed intake, and although less accurate than direct feed-efficiency testing, it will nevertheless enable breeders to identify the cattle with the genetics needed for superior feed efficiency — a boon that is expected to save the industry around $200 million in total by 2020. The environment wins too, because the more feed-efficient cattle will produce less of the greenhouse gas methane.

Top: Providing feed to cattle is the greatest expense — how do Australian farmers find the most efficient cattle?

Middle: Accreditation ensures that estimated breeding values for feed efficiency are accurate.

Bottom: An inexpensive blood test helps select for feed-efficient bulls.



Banana-savers

CRC for Tropical Plant Protection

Top: Symptoms of black Sigatoga on a banana leaf.

Middle: CRC researcher Juliane Henderson carrying out a molecular diagonostic test for the disease.

Bottom: A stand of banana plants infected with black Sigatoga.

Healthy plants matter a lot to Australia's thriving banana industry. Australia has been lucky: its geographical isolation and strict quarantine regulations have protected banana-growing areas from many maladies that affect the industry in other countries.

However, with increasing international trade and travel, the risk is always there that diseases and pests of bananas could be introduced into Australia. This has already happened once. In 2001, Queensland's Tully area (which produces nearly 40% of Australia's bananas) was struck by black Sigatoka — an exotic fungal disease. Wet weather both enhanced disease spread and hampered diagnosis by washing away the fungal spores necessary for accurate identification. In addition, traditional methods did not adequately distinguish between black Sigatoga and the less-destructive and commonly occurring yellow Sigatoga, compounding the problems for quarantine authorities trying to manage the outbreak.

Fortunately, the CRC for Tropical Plant Protection had developed molecular diagnostics tests for black Sigatoka, which made it possible to confidently and rapidly identify the disease without the need for spores. The method was also about seven times faster than the traditional one, making the overall eradication process more efficient as well. It is estimated that this intervention had saved the industry around $43.6 million in potential losses by 2002.

Warned by this experience, the CRC — in collaboration with its partners — has moved to enable the industry to detect and manage eight different exotic banana diseases, any one of which could threaten the livelihood of banana-growers. In the quest to avert future outbreaks, the Northern Australia Diagnostics Network was created — linking researchers, industry and government agencies in a common endeavour to protect bananas and other tropical commodities. One outcome of this process has been an agreement to employ a banana pathologist full-time, with industry funds and government support, to pre-emptively prepare for any threats that may arise.

For an industry with a farm-gate value of $295 million a year, that's cheap protection.

Row, row, row your boat

CRC for microTechnology

Those who take part in or coach competitive rowing need detailed information on a complex range of inter-related matters if they are to improve their performance. Over the years, various devices have been used to monitor high-level rowers during training or competition but many of them had drawbacks, not least that the rowers themselves found them irritating.

Among the information sought, bodies like the Australian Institute of Sport (AIS) look for data on the speed of the boats and of the amount of stress suffered by the rowers. For the boats, it became common to attach impellors under the shell, and later experiments were conducted into estimating the speed of the boat with the aid of global positioning systems. As for the rowers, they were sometimes asked to wear monitoring devices that could display and log their heart rates every few seconds. But none of these measures provided the accurate, integrated detail that the rowing coaches and scientists were after.

Heart rates turned out not to tell the experts much once rowers got beyond a certain point of intense effort; and the impellors on the boats tended to cause drag, get entangled with weeds, and, in any case, didn't account for the speed-up/slow-down progress of a boat from stroke to stroke.

Now the CRC for microTechnology, in conjunction with the AIS, has developed a new monitoring system named the *Rover*. This consists of sensor modules which can transmit information to a display unit installed in the boat and also to a receiver placed in a coaching dinghy as far as 70 metres away.

The new sensors and display unit weigh only 250 grams and send their data wirelessly, which makes them more acceptable to rowers. The latest *Rover* was used extensively by Australia's 2004 Olympic rowers.

Australian Olympic rowers training with *Rover*.

Learning to beat the pests

Australian Cotton CRC

Integrated pest management workshops cover many topics, including: identification of beneficial insects as well as pest species (top); practical management of cotton crops (middle); and discussions where participants can share their experiences and knowledge (bottom).

Gardeners know the irritation of seeing their plants attacked by insects that they can't identify and don't know how to destroy. But what if you're running a multi-million industry like cotton?

The potential losses from insect infestation make it imperative that cotton-growers are up to date with the latest research and know how to apply it. That's why the Australian Cotton CRC has initiated a special course in integrated pest management (IPM) which it regularly makes available to producers, especially field managers.

The course begins with two days of discussions between researchers and participants in the winter (off-season) months, during which the latest research is introduced and its applicability to IPM explained. The course continues for two days on a grower's property during the production season, giving participants 'hands-on' experience of how research theory can apply to practical management. Finally, participants share their experiences in further discussion sessions.

What makes this course unique is that it brings together researchers, extension officers and growers in a way that makes technical knowledge accessible and allows growers to apply it to their crops. It has been recently estimated that the CRC has saved the Australian cotton industry over $300 million in costs associated with pesticide use. The IPM short course has played an important role in achieving this outcome.

More than 16 courses have already been conducted with the involvement of extension officers from the New South Wales and Queensland governments, researchers from those two States, and other researchers from CSIRO.

Many of the participants decide, after the course, to change their farming practices so as to incorporate the application of the knowledge they have gained. Insects are persistent, but so are the cotton-growers and thanks to the IPM courses, they have a much better chance of reducing the devastation that insects can wreak on a crop that contributes heavily to the Australian economy.

Out of the labyrinth

Coastal CRC

CRC for Coastal Zone, Estuary and Waterway Management

Tourist brochures of Australia almost always feature the coast. Most Australians like to live near, or at least visit, the coast with its beaches, scenery, and waterways. But when everybody wants to use this part of the country for their own personal pleasure or business, the potential for disagreement and even conflict becomes enormous, not to mention the impact on the coast!

Governments make laws and regulations to avoid such conflict, and scientists and others are employed to research how the coast can be managed to keep it free from degradation while still allowing people to enjoy it and use it. But this isn't as simple as it might sound. Citizens nowadays are not content to leave everything to government and, in any case, different levels of government may have different ideas about the best way to manage the coast. Masses of factual information won't solve the problems on their own either: processes are needed to bridge the gap between decision-makers and citizens who want a significant say.

Processes to help citizens find a way through this labyrinth of information, legislation and competing needs have been compiled by the CRC for Coastal Zone, Estuary and Waterway Management into a Citizen Science Toolbox.

Available on the Internet <www.coastal.crc.org.au/toolbox/index.asp>, the Toolbox offers citizens effective ways to engage in coastal decision-making about issues that concern them. On the website can be found details of over 60 tools to assist community involvement. In addition, the Toolbox offers:

- case studies of how the various tools have been used and how satisfactory the people involved actually found them
- an annotated bibliography of more than 500 references
- theoretical discussions of what citizen involvement can achieve.

What's more, although the Toolbox concentrates on the coast, the principles and tools it provides can be used in many other areas for purposeful and effective citizen involvement.

Top: The Toolbox is designed to assist the process of stakeholder participation in decision-making.

Middle: Image from the homepage of the Citizen Science Toolbox.

Bottom: Open space technology — one of the tools in use.

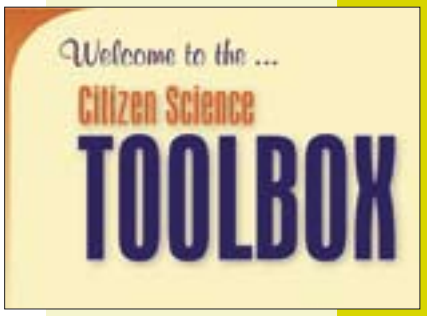


Photo: James Whelan

Fighting salinity

CRC FOR PLANT~BASED MANAGEMENT OF DRYLAND SALINITY

CRC for Plant-based Management of Dryland Salinity

Top: Sheep grazing in a field of lucerne.

Middle: Cropping of perennial lucerne can be sucessfully used as a component of a salinity management strategy.

Bottom: Deb Slinger (NSW Dept of Primary Industries) leading the discussion at a CRC workshop for Landmark agronomists.

Salinity threatens agricultural production, natural resources and infrastructure across large areas of southern Australia. To counter it, significant changes to current farming practices are required. As one approach, the CRC for Plant-based Management of Dryland Salinity is developing profitable, perennial-based agricultural systems which will control the 'leakage' of rainfall into groundwater that results from current annual-based farming. This leakage causes the watertable to rise, passing through layers of salt stored in the soil profile and bringing it to the surface, and on to our rivers and wetlands. Fortunately, the perennial lucerne is showing good immediate promise, while work continues on other, more innovative plant-based solutions.

The challenge now is to convince the farmers concerned — about 30,000 of them — that these crops can turn a profit as well as reduce the salinity problem. While State agriculture departments, which are partners in the CRC, can translate the principles into practices that suit the particular circumstances of individual farms, it is not their role to provide one-to-one advice.

This is where the CRC has partnered with the expertise and manpower of Landmark, a major agribusiness firm that has a network of 230 branches and more than 200 affiliate agency locations. Together with State agencies, they have launched a project to expand the cultivation of lucerne to tackle salinity. The CRC makes its information on perennial pasture plants available to Landmark through training sessions, demonstrations, and an interactive website; then Landmark agencies help the farmers to implement national, State and regional plans for managing salinity. Farmers then provide feedback that is passed back to government and the CRC.

This project is now in its second year and already 334 Landmark agronomists have carried out the first round of local workshops, and 73 have completed a second round. Farmers are showing enthusiasm for the project, which potentially limits salinisation of their land and helps maintain their businesses.

Contact for vision

Vision CRC

Most people are aware of the existence of contact lenses, but studies have shown that only 5% of Australian patients who need glasses choose these lenses — a substantially lower percentage than in other, similar markets. Research by the CRC for Eye Research and Technology (now the Vision CRC) and the Institute for Eye Research revealed that a major reason for this was very simple: eyecare practitioners were just not recommending contact lenses. Consequently, patients assume that such lenses are not suitable for them.

In response, the CRC developed a training program for optometrists and other eyecare practitioners to increase the sales of contact lenses, with benefit both to patients and to the practitioners' businesses.

The program was started with a pilot project involving 20 optometric practices in the Sydney area. The optometrists and their staff took part in workshops and training exercises that included selling and communication techniques as well as patient management. After the training, all practices were given continuing support and updated information.

As a consequence of the pilot scheme, the practices achieved an average growth in contact lens sales of 21%. Six practices achieved over 40% growth and one rated growth as high as 68%.

The project was not only aimed at increasing sales of contact lenses for the sake of the optometry businesses: practitioners were also taught to be actively aware of the special needs that some patients may have for contact lenses. Often people would prefer contact lenses to glasses to play sport, for example, or for cosmetic or social reasons.

The pilot program proved highly successful and will lead to a permanent project. Its success was attributable to the combination of the professional knowledge of the Vision CRC, its expertise in developing educational courses and material, and the industry's knowledge of contact lens marketing.

Top: Increased contact lens business can significantly improve the profitability of optometic practices.

Middle: Contact lenses offer vision and lifestyle benefits to many people.

Bottom: The Vision CRC has taught optometrists and their staff better communication and business management skills.

The right signals

RAIL CRC

CRC for Railway Engineering and Technologies

Top: Field visit during February 2004 course induction program in Sydney.

Middle: Welcome address to initial course intake by the Rail CRC's CEO, Professor Dudley Roach.

Bottom: Course learning materials.

Many people know that when railways came to Australia, the Colonies adopted different gauges of track, but it is not always appreciated that different signalling engineering practices also survived Federation and numerous attempts at standardisation. As a result, the States' railways still differ considerably in signalling equipment and practices.

Each State needs qualified signalling engineers for its railways, but these days they are hard to find, and with the differences between States, it is not always easy for an engineer to move to another State without re-training. As a step towards improving the situation, the CRC for Railway Engineering and Technologies has sponsored the development of a Postgraduate Diploma in Railway Signalling, in conjunction with the Central Queensland University.

The course leading to the Diploma is unusual in two ways: first in specialising in railway signalling (it is the world's first and only program of this kind for the railway signalling profession), and second in that it is offered through distance education with online support. This has resulted in several benefits for both students and their employers. Students can study on the job, the course can be followed regardless of where the student lives, and students can work cooperatively on projects — in constant touch with the teaching staff — and thus share experiences and insights.

The workload is made more manageable by being spread over 48 weeks of the year instead of following traditional academic terms; and the use of print-based material, the Internet and multimedia CDs also makes study as flexible as possible.

The first intake attracted 30 engineers from all the mainland States, and much international interest has also been shown, not least because many countries are experiencing a similar shortage of fully trained signalling engineers. Planning is currently under way to extend the offering of this program to railway signal engineers in the United Kingdom.

Warriors fighting weeds

CRC for Australian Weed Management

Winner

Shakespeare's Hamlet condemned the world as 'an unweeded garden that grows to seed; things rank and gross in nature possess it merely'. Without being quite so gloomy, most people will share Hamlet's dislike of weeds, especially those who constantly battle to get rid of them for the sake of growing not only garden plants but all the crops we need.

But how to fight 'things rank and gross in nature' effectively? Since weeds are everywhere and spread vigorously, the CRC for Australian Weed Management has undertaken an ingenious and innovative campaign against them. The campaign, called Weed Warriors, combines an effective approach to weed eradication while at the same time giving school children a novel educational experience.

The campaign begins with the recognition of local weeds and goes on to encourage school groups to grow approved insects which are known to attack those weeds — and only those.

The CRC provides the school groups with the equipment and techniques for growing the insects, which are usually bred over four to six weeks. Then the Weed Warriors release their 'bugs' at the infestation sites of the chosen weeds. Naturally, this attracts attention from parents and friends. Word soon gets around and local government and the whole community start to realise that weeds don't have to be endured and that something positive can be done about them.

So far, 125 Weed Warriors networks have been set up, involving 3000 students, 125 teachers, 100 weed officers, 15 biological control researchers in 6 States, and 19 government agencies. Everyone learns from everyone else in such an extensive network; and weeds are getting the comeuppance they deserve.

Top: Gorse being invaded by gorse spider mites, one of the biocontrol agents raised under the Weed Warriors program.

Middle: Students involved in the Weed Warriors program at a Weedbuster Week 2003 display at Rundle Mall, South Australia (SA).

Bottom: Students from Upper Sturt Primary School releasing bridal creeper leafhoppers under the guidance of the local weeds officer at Belair National Park, SA.

Photo: P. Martin, Weeds CRC

Photo: S. Vidler, Weeds CRC

Photo: V. Hawker, SA Animal & Plant Control Commission

Colourful coral

Sustainable Tourism CRC

Top: Research team of Associate Professor Justin Marshall, Kylie Jennings and Ulricke Siebeck.

Middle: Example of a small patch of bleached coral.

Bottom: Heron Island, located at the end of the southern end of the Great Barrier Reef.

The Great Barrier Reef is such a tourist attraction that the bleaching of its coral could prove disastrous. Yet this happens periodically for reasons that are not fully understood.

Scientists keep an eye on the coral as far as they are able, but generally can only do so where they happen to be working. Even then, they may have to use invasive methods of sampling live tissue to check the coral's physiological health. Otherwise, the task is carried out by costly satellite-borne technology.

Now the Sustainable Tourism CRC and one of its participants, the University of Queensland, as well as P&O Resorts Australia, have got together for a highly original way of enlisting tourists themselves to monitor and learn about the spectacular reefs that they come to see.

Coral Watch simply consists of an inexpensive, easily used colour chart. Tourists and others are invited to use the chart to match the colour of the coral they see and then record the results. In this way, massive amounts of data can be collected. The records are sent for analysis and the results are made available on the Coral Watch website <www.coralwatch.org>.

The development of the charts was achieved by an unusual cooperative operation by two centres at the University of Queensland: the vision and colour experts at the Vision, Touch and Hearing Research Centre and the coral experts at the Centre for Marine Studies.

The cause of bleaching appears to be the loss of the algae on which the coral feeds but why the algae are expelled is still unknown. By enlisting large numbers of people to use the Coral Watch cards, researchers hope to gain enough information to probe further into the mystery.

Importantly, the cards enable anyone in the world to monitor their local coral without expensive equipment and training.

A sticky problem

Australian Cotton CRC

In 2001–2002, Australia's cotton industry faced a potentially devastating threat. For the first time, an insect called the silverleaf whitefly appeared in problematic numbers in Australian cotton — apparently introduced 10 years earlier on imported nursery plants that escaped quarantine inspection.

Whitefly leaves a sticky substance called honeydew on the plants it feeds off, and this can make cotton virtually unsaleable. The insect reproduces rapidly, swiftly develops resistance to insecticides, and becomes widespread because it also attacks a multitude of other plants, including peanuts, melons, sunflowers, soybeans and numerous garden plants and broadleaf weeds.

The Australian cotton industry knew of the dangers from the experience of Arizona, USA, which had similar problems in the early 1990s. Although whitefly was brought under control through a successful management strategy, cotton from Arizona acquired the fatal reputation on the world market that it has been unable to shake. To avoid a similar fate, the Australian Cotton CRC quickly implemented a campaign of control.

Cotton industry personnel, including growers, consultants, and researchers, visited the USA to see how the pest was being controlled there, and a leading American expert was brought to Australia to share his expertise. Farmers, industry, researchers and the general public were all made aware of the threat, shown how to recognise whitefly, and urged to cooperate in a series of tactics designed to control it and minimise the damage. Because the Cotton CRC already had an extensive and effective network at its disposal, the necessary steps for control — which it had taken Arizona five years to develop — were in place within one year.

Whitefly will probably continue to challenge the industry, but thanks to speedy action, effective education, and the rapid adoption, the threat has been controlled. That means a lot to an industry that produces about 3.2 million bales of cotton a year, with an export value of $1.5 billion.

Top: Cotton lint tarnished with honeydew from silverleaf whitefly.

Middle: Area-wide management groups, including farmers, advisors and CRC staff, meet monthly during the cotton season to discuss management strategies.

Top: A large population of silverleaf whitefly on the underside of a cotton leaf.

A sound education for professionals!

CRC for Cochlear Implant and Hearing Aid Innovation

Top: Each workshop program is supported by a comprehensive technical manual.

Middle: CRC HEAR conducts its workshop program through participation of key staff and use of facilities of its core and support parties in Melbourne and Sydney.

Bottom: Workshop surgical training at the Skills Centre of the Royal Australasian College of Surgeons.

Australian research and developments in hearing aid and cochlear implant technology and clinical procedures are well known internationally. Over 50,000 adults and children with hearing loss can now hear — thanks to the advanced cochlear implants manufactured in Sydney by Cochlear Limited.

But the cochlear implant is not a simple 'plug-and-play' device. It needs an interdisciplinary team of surgeons, clinicians, teachers and other professionals to ensure that it is provided to suitable patients, that the surgery is conducted safely and effectively, and that appropriate rehabilitation and counselling are provided to adults or children to enable them to learn to make best use of the implant. The expansion of selection criteria to include people with more residual hearing, and the growing complexity and choice in cochlear implant technology, has meant that surgeons and clinicians need to have up-to-date knowledge and training to make the right choices.

To meet this need, the CRC for Cochlear Implant and Hearing Aid Innovation (CRC HEAR) has for some years been developing a suite of training workshops to ensure the effective provision and management of cochlear implants to children and adults — servicing over 2000 surgeons and clinicians from more than 22 countries to date.

Within Australia and throughout the region, new clinics are being established to help those with hearing loss or difficulties. Cochlear Limited, through its partnership in CRC HEAR, ensures that these new clinics can take advantage of the workshop programs so that patients can be certain of the best possible surgical care and post-operative outcomes.

The suite of workshops has been expanded to include specialist surgical sessions, a comprehensive paediatric program, and more recently, an advanced problem-solving workshop providing skills to deal with difficult and complex patient cases. The program is supported by comprehensive manuals and audio–visual materials. An on-line version of the training program will make it even more widely available. Program materials have now been translated into Mandarin to facilitate expansion of the workshop into China.

Outfoxing the fox

Pest Animal Control CRC

Pest Animal Control CRC

Foxes are one of the many pests that were brought to Australia to make it look more like 'home', but until recently, Tasmania was fortunately free of them. However, during 2000, somebody deliberately imported the fox to the Island State. The Pest Animal Control CRC took up the challenge and moved swiftly to enlist the help of farmers and others in the eradication of the fox.

In 2003, the CRC, together with the Fox Free Tasmania Taskforce and Australian Wool Innovation Ltd, developed a program known as OutFoxII — a public awareness, education, research and training program for Tasmanian woolgrowers which built on the success of the original OutFoxI scheme. The program has also benefited greatly from training and support offered by other national and mainland State bodies.

OutFoxII has been implemented using five main approaches: 'Farm Notes' to alert farmers to the dangers and explain methods of monitoring and control; face-to-face training and information sessions for rangers and farmers; production of two instructional videos; a program of research into detection methods for foxes and other carnivores; and distribution to farmers of a first-aid guide for use with dogs which might take a 1080 bait (and is now widely available in other States).

The OutFoxII program has been enthusiastically taken up by farmers and woolgrowers, whose cooperation is essential in monitoring the presence and location of foxes and the effectiveness of eradication programs. In addition, the general public is being made aware of the threat through the wider distribution of the information videos, including to the many schools that have asked for them.

Because the program has to operate at many levels if it is to succeed, it was important to have an organisation that could call on numerous participants and build a strong collaborative network. The CRC is ideally placed for this purpose and its work is already showing that good teamwork can outfox the fox.

Top: NSW State Forests ecologist Paul Meek inspects a trapped fox as part of the OutFoxII training course.

Middle: OutFoxII — helping to control Australia's main predator threatening Tasmania's wildlife and agriculture.

Bottom: Members of the Fox Free Tasmania Taskforce inspecting dead foxes killed during mainland training at Orange, NSW.

Education for a dispersed industry

CRC for Cast Metals Manufacturing

Top: CAST vacation student Thy Vo working with industry.

Middle: CAST specialises in training for the light metals industry.

Bottom: Personnel at Nissan work with CAST researchers to solve production problems.

The light metals industry is currently worth over $7.0 billion a year to the Australian economy, with significant global growth in the industry forecast over the next 20 years. An educated workforce is crucial for Australia to capture an increasing share of the global light metals market. However, light metal companies in Australia are scattered across the country and rarely have the critical size necessary to deliver comprehensive in-house training programs. Such programs are also not offered by education providers because of the small number of students involved at dispersed locations.

The CRC for Cast Metals Manufacturing (CAST) has stepped in to help solve this problem by offering industry-specific educational programs with flexible delivery that cater directly to the needs of these small but valuable enterprises wherever they may be located.

Working together with educators, researchers and industry, CAST has created a national education program to provide training opportunities to Australia's light metals industry.

The result is CAST's innovative Light Metals Education Program that is centralised and nationally accredited, yet capable of being provided to all kinds of learners at home, at universities, at TAFE colleges, or at their place of work.

The program employs the latest methods of distance education to ensure that no students are disadvantaged. The key to the Program's success is that it works within the existing framework of TAFE and university courses, collating leading-edge content, drawing on expertise from CAST researchers and giving students access to a range of institutional resources.

An added benefit of the program for Australia's light metals industry is that new approaches and technical innovations can be delivered directly to workers on the shop floor. This means that as well as benefiting from access to continuing education, the workers can also implement the latest technological developments to the betterment of their employers.

Winner

Cleaner air by smart coal selection

Bart Buhre
CRC for Coal in Sustainable Development

Ash particles are formed during the combustion of coal in power stations. The majority of these particles are captured and not emitted, however small ash particles are not easily intercepted and a small quantity is released into the atmosphere. These fine particles can cause health and environmental problems.

Can we collect these fine ash particles? According to Bart Buhre, the answer is yes, but it's difficult and expensive. But, what if the emissions of fine ash particles could be reduced by careful selection of the type of coal that we burn?

Working with the CRC for Coal in Sustainable Development, Bart has studied the combustion process and has found that there is a big difference between various coal types when they are burned. He showed that the amounts of certain components like sulfur and vitrinite in the coal are related to how much fine ash is formed during combustion.

Evolving optical fibres

Steven Manos
Australian Photonics CRC

In a world of high-speed data transmission, optical fibres are of fundamental importance. They are used in everything from medical imaging to sensing temperature. But designing them has so far been a labour-intensive and expensive job.

Steven Manos is simulating nature to help design high-performance optical fibres that are cheap and easy to make — and to do this, he has incorporated ideas from computer science, physics, engineering and biology.

Nature's own design machine is the key. By looking at different fibre designs as organisms, Steven can use a computer to simulate evolution — allowing the design process to work without human intervention.

Thousands of random fibres are produced, then mutation and 'breeding' allow the exchange of characteristics. The 'fittest' are chosen for further breeding and eventually the bad designs can be filtered out.

After many generations, a range of better fibres remains, each with characteristics that suit them to specific applications.

Plants at war

Ken McGrath
CRC for Tropical Plant Protection

What happens to a plant that is under attack from a fungus? It may seem quiet to us, but there is a molecular war being waged. Defensive weapons get made by the plant, and there is a group of genes that control this defence system. Recent research has identified two such genes.

One wakes up the defence system, gets it moving and raises its level of activity. The other gene stops the defences being made, and keeps the troops in check when there is no fighting to be done.

Plants have been developed to produce altered levels of these genes' products, so the plant's defence mechanisms have a head start in the war against its fungal foe.

Ken McGrath is studying these plants to see whether the same principle can be transferred to valuable crops that suffer fungal attack, such as cotton, wheat and barley.

Agriculture and rural based manufacturing

The sex-life of rice

Sandra Oliver
CRC for Sustainable Rice Production

When rice gets cold, it can't cuddle up in bed. Instead it suffers a stress which damages its reproductive organs, particularly the male, pollen-producing organ of the flower. This causes the plant to abort its sex-life and become sterile — so it stops producing grain.

Cold weather disrupts the rice plant's sugar metabolism and causes a blockage in sugar transport within the flower. As a result, the pollen in the flower is starved and dies.

Even in Australia, the weather frequently gets cold enough to cause this stress and millions of dollars worth of rice is lost.

Sandra Oliver is part of a team that is investigating how all this is controlled by the rice plant's genes. They have found that a hormone may be the key because its level increases dramatically in cold weather.

Selective breeding for hormone change might be able to protect the rice — and its sex-life.

Salt for your cereal?

Alaina Garthwaite
CRC for Plant-based Management of Dryland Salinity

Dryland salinity is now widely recognised as one of the greatest threats to Australia's environment, and particularly to farming. Efforts to halt salinity in agricultural areas all take time and meanwhile crops have to be grown.

Alaina Garthwaite, knowing that salinity is not going to go away quickly, if at all, is researching the possibilities of growing cereal crops that can cope with it.

In fact, there are wild varieties of barley and wheat which have long grown happily in saline and waterlogged soil. Alaina's research and contact with overseas colleagues have shown that these wild cereals put down a snorkel-like root system that allows them to 'breathe' under water.

What if these 'wild' cereals could be used to breed new varieties of wheat and barley which would share their tolerance for salinity and waterlogged soil? Alaina's answer to this could also be the answer for embattled farmers.

Wipe your boots — and ute!

John Harvey
Australian Cotton CRC

Recent years have seen the arrival of a new disease to the Australian cotton industry — black root rot, a soilborne fungus that can cost farmers $2500 per hectare.

By surveying cotton catchments, John Harvey found that the fungus which causes black root rot is rarely detected off-farm, and when found, it is only present in highly disturbed sites such as roadsides. DNA testing shows that the roadside strains are unlikely to be the cause of disease in Australian cotton.

The most likely source of the disease in cotton crops is movement of soil between farms. Soil can be moved through adhering to boots, machinery and vehicles — including the farm ute.

While work continues to find controls, prevention remains better than cure, so there is a real benefit to maintaining farm hygiene. Or to put it simply — cleaning the farm ute could save farmers millions of dollars.

A hidden world of water microbes

Daniel Hoefel
CRC for Water Quality and Treatment

When water supply authorities want to identify bacteria in water, they grow cultures of them in the laboratory. But now they realise there are some bacteria that can't be cultured that way.

Daniel Hoefel's research into other ways of detecting them utilised a hospital instrument known as a flow cytometer. With this, he was able to detect in water hundreds to thousands of bacteria that couldn't be found in the traditional way, and detection was reported within hours instead of days.

None of the bacteria he has found are likely to cause disease, but the techniques are capable of detecting a world of microorganisms unknown to, and untraceable by, the traditional methods of water analysis.

Adoption of techniques used in Daniel's research promises better assessment of water treatment efficiency and the integrity of distribution systems, and so greater safety for the water we drink.

Mangrove nurseries

Ross Johnston
CRC for Coastal Zone, Estuary and Waterway Management

On large areas of the Australian coast, the tide ebbs and flows through mangrove swamps. These mangroves have long been recognised as nurseries for fish, but just how the fish use them has been uncertain.

Ross Johnston has used innovative scientific methods to discover what happened to the small fish when the tide was out and they couldn't access mangrove forests and other intertidal habitats. He found that they usually stay in the shallow water along the edge of the main channels that remain after the tide has ebbed. When the tide rises, they follow the shallow edge back into the mangroves.

Access to shallow intertidal habitat is essential to the survival of little fish; without it, populations of many important fish species would rapidly decrease. But mangroves and other intertidal areas are constantly being modified for development and industry.

Ross's research shows just what the consequences will be — depleted stocks of valuable fish species.

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