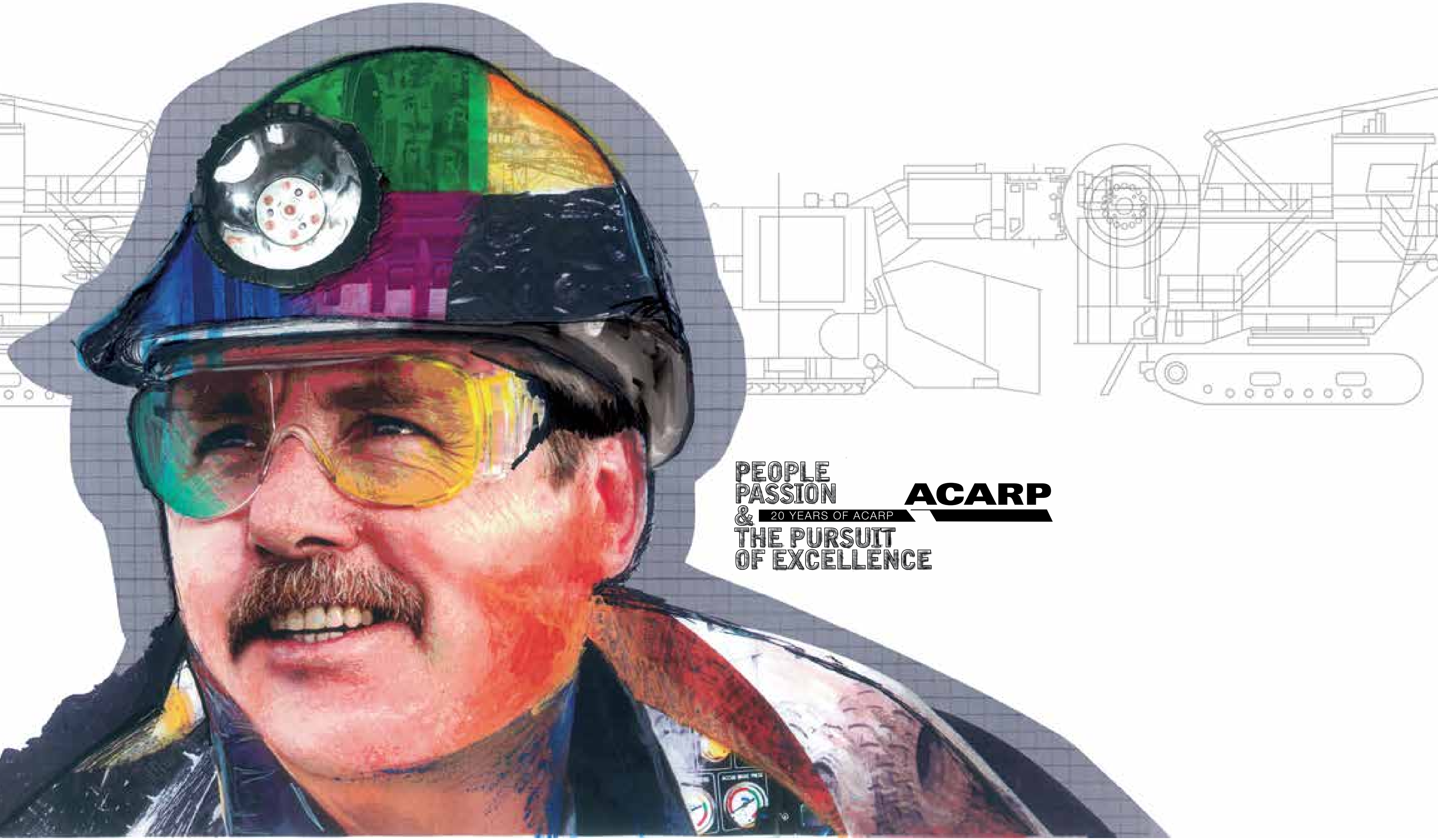

PEOPLE PASSION & THE PURSUIT OF EXCELLENCE

20 YEARS OF ACARP

ACARP

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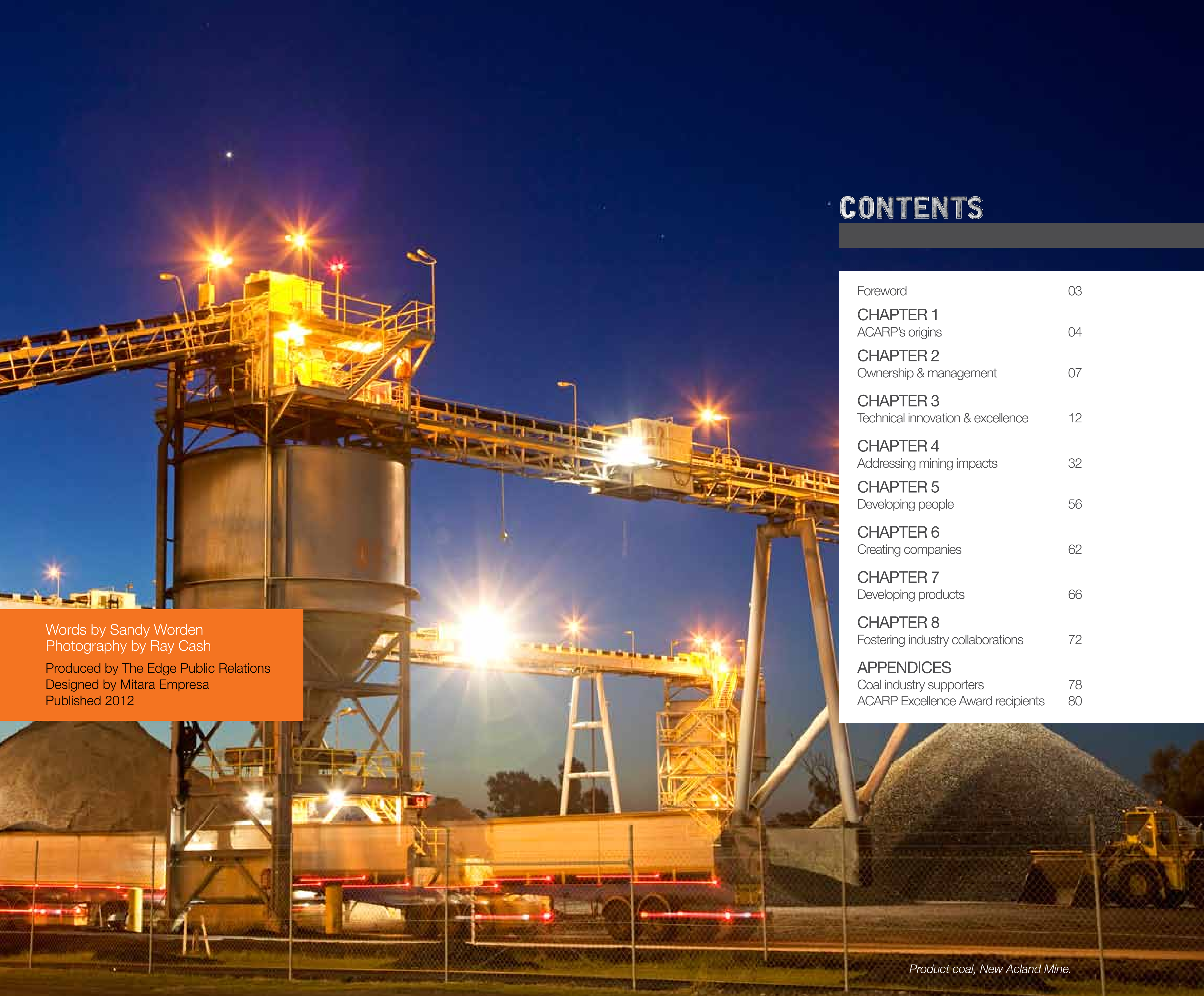
Loading coal, New Acland Mine.



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Product coal, New Acland Mine.

FOREWORD

> “The outstanding achievements of the Australian coal industry could not be accomplished without the passion and the contribution from the people.”

Australia is one of the world’s largest producers and exporters of coal and is at the forefront of the global pursuit of sustainable mining.

Underpinning this success is Australia’s research expertise and experience.

The Australian Coal Association Research Program (ACARP) provides a critical leadership role in assisting Australia’s coal industry to develop and adopt world leading sustainable mining practices through industry collaboration.

This year marks the 20th anniversary of ACARP, giving us the opportunity to reflect, acknowledge and celebrate the contribution of the people who make ACARP such a successful program.

ACARP is unique in the world and highly successful. It was established in 1992 through a Memorandum of Understanding between the Australian Coal Association Executive and the Australian Government. ACARP is industry funded with a levy of five cents per tonne of product coal paid by Australian black coal producers. ACARP’s research covers a wide range of important areas including safety, productivity and environment sustainability. By the end of 2011, ACARP had provided $210 million in funding to 1195 projects.

ACARP has contributed to Australian coal research in a way that individual companies could not have otherwise achieved. It combines resources and expertise from individual producers and shares the risks and benefits across the industry.

The outstanding achievements of the Australian coal industry could not be accomplished without the passion and the contribution from the people, who are determined to pursue mining excellence that underpins Australia’s economic prosperity and world leadership in sustainable mining practices.

Martin Ferguson
Minister for Resources and Energy

1 ACARP'S ORIGINS

STATE RIVALRY SET ASIDE TO KICK GOALS FOR WORLD-CLASS COAL RESEARCH

A long-term collaborative effort by passionate industry people and an unwavering pursuit of technological excellence has ensured that the Australian Coal Association Research Program (ACARP) has secured its place as the most successful coal research program in the world.

Although it had a precarious start, the program now invests $15 million in 70 projects annually through a voluntary levy of five cents per tonne of saleable coal from every black coal producer in the country. The levy represents somewhere between 0.01 per cent and 0.1 per cent of coal industry revenue, depending on coal price. The program boasts 13 committees and task groups, comprising 151 company representatives.

ACARP was established on 22 January 1992 through a Memorandum of Understanding between the Minister for Primary Industries and Energy and the Chairman of the Australian Coal Association. It replaced the coal research and development component of the National Energy Research Development and Demonstration Program (NERDDP), which had not enjoyed widespread industry support for some time, particularly around the relevance of projects selected and the quality of research outcomes. In addition, some companies questioned whether the compulsory funding levy, which was matched by the Commonwealth, was warranted given the economic climate at the time. Collaborative, coal industry-funded research and development as part of NERDDP had been introduced by the Minister for Trade and Resources Doug Anthony in 1977 through the Coal Levy Act to ensure an ongoing industry commitment to coal research. Project selection and expenditure was recommended by the tri-partite production and coal use committees which comprised government, research and company representatives. NERDDP was supported by a Commonwealth secretariat.

Given industry's growing dissatisfaction with NERDDP, the Australian Coal Association (ACA) charged its Chairman Ian McCauley with negotiating a better arrangement with the Minister for Primary Industries and Energy John Kerin.

The ACA, which comprised three representatives from the New South Wales Coal Association and three from the Queensland Mining Council, was known as 'The Six Pack'. It proposed three options: to remove the levy completely (which it acknowledged was unlikely to occur); to reduce the levy; or to have the coal industry assume control over its own research program so that it could invest research funds more strategically. These negotiations began in 1989 and continued for three years.

"Minister John Kerin was pretty sympathetic to the view that the coal industry should be managing its own research fund, but one of the conditions he put on the ACA was that 100 per cent of our members had to be willing to come into the scheme, replacing the compulsory levy with a voluntary one. As I remember we had a little difficulty getting 100 per cent agreement, but eventually we were successful," Ian said.

ACARP was established as a three-year trial until June 1996 to provide strategic leadership to industry research and development (R&D), to act as a catalyst to stimulate interest in that R&D, and to foster a collective and integrated approach.

ACARP was committed to funding research into all aspects of the production and utilisation of black coal including health, safety and the environment. Projects would be selected according to their strategic and immediate value to industry. Management of ACARP was to be the responsibility of the newly formed company Australian Coal Research Limited (ACR) with a board of directors appointed by the ACA. The first Executive Director, Ross Graham, was appointed in October 1991.

ACR was registered as the intended responsible corporate management entity for ACARP on 5 December 1991. ACARP made its first call for

The old interstate rivalry is a thing of the past ... really!

Geoff Oldroyd (Queensland), Geoff Sharrock (New South Wales) and Bruce Robertson (Queensland) reminisce about ACARP's early days.

research papers in June 1992 with $5.9 million allocated to 45 projects in the first round. The process of transferring responsibility from NERDDP was completed on 26 June 1993 when the final piece of legislation – the *Coal Tariff Legislation Amendment Act 1992* – was passed. This Act meant that coal producers ceased paying a compulsory levy to the Commonwealth. By individual Deed of Agreement completed with each coal producer, an equivalent levy became payable to ACR from 27 June 1993.

Bruce Robertson, former Research Committee Co-chairman and long-time ACARP supporter, developed a proposal for the running of the program, including a purpose, vision, strategy and tactics.

"I put that to the committees and we took it through a couple of phases until it was ready to go through Ian back to the ACA. They liked what they saw, approved it, and it became the guidance document for how we were going to set up the committees. Then there was a lot of work to identify how we were going to service the committees because our team was just mining engineers, metallurgists and geologists who came to meetings, and we didn't have a secretariat," Bruce said.

Prior to the establishment of ACARP, coal industry research was coordinated by NERDDP at the national level, but the New South Wales Coal Association and the Queensland Coal Owners Association also funded research projects. Now all research would be coordinated through one program.

Establishing a workable structure required some finessing as there were practical and priority differences between Queensland and New South Wales, with some healthy rivalry at times. Not only were there differences in state legislative arrangements, but there were also differences in the conditions and mining methods. At the time, the New South Wales coal industry predominantly comprised underground longwall and bord and pillar mines congregated around the Illawarra and lower Hunter, and open cut mines in the Hunter Valley. The underground mines faced significant gas issues and were managed by companies of diverse sizes and cultures. By contrast, Queensland was largely open cut based, with mines owned by a handful of large companies and an emerging underground sector. Queensland had fewer underground gas issues and a strong interest in productivity improvement, efficiencies and equipment-related safety issues.

The new structure encompassed a Research Committee that was responsible to ACA through ACR, and which coordinated the output from three committees – underground, open cut and coal preparation. A number of issues were addressed by task groups reporting to the committees. To ensure appropriate representation, each committee had co-chairs and the meetings were held in each state on an alternate basis. The New South

The Australian Research Adminstration team: Nicole Youngman, Roger Wischusen, Anne Mabardi and Jim Craigen.

Wales meetings were chaired by that state's co-chair and vice versa. In 1993 the Australian Minerals Industry Research Association (AMIRA) was appointed to provide major program support. After a significant restructuring of the project management arrangement in 1998 following a comprehensive review of ACARP's operation, AMIRA was replaced by Australian Research Administration (ARA), which continues to provide ACARP's project administration and secretariat support services.

Bruce said one of the issues with NERDDP research was that its outcomes tended to be researcher-orientated and not easy to implement or transfer across mine sites leading, in turn, to low levels of satisfaction among industry leaders.

"The thinking behind the new ACARP structure was that we needed a high level of engagement with the ACA through the ACR Board because we didn't want to end up in the same place as NERDDP with a disconnection between the decision-makers," he said.

Geoff Sharrock, former Research Committee Co-chair, said one of the keys to ACARP's success had been the willingness of technical people – geologists, plant metallurgists and mining engineers – to share scientific information for the benefit of the industry.

"There was never any problem at the technical level. We were willing to exchange data from companies, give our time, give our technical expertise and opinions, and it worked well," he said.

"In the 1980s people used to sit at minerals council / coal association tables and say that our longwalls don't produce as much coal as American longwalls, our draglines don't move as much dirt as American draglines and our safety's not as good as theirs. Now it's the reverse. I'm not going to attribute all of that to ACARP but I'm going to attribute quite a lot of it.

"I'd also like to pay tribute to Howard Jones OBE, who was a superb Chair of the National Energy Research Development & Demonstration Council Technical Standing Committee 2; a wonderful fellow and a real pleasure to work with. He taught me a lot and that allowed me to be a better chairman of the Research Committee."

Geoff Oldroyd, a past Research Committee Chairman, said that research and technology would remain critical in sustaining future competitiveness in an industry faced with technical, operational and human resource challenges as mines became deeper and the best quality deposits were depleted.

"Recognising that no one company can realistically develop all its own technology, the ACARP model has effectively demonstrated the wisdom of pooling research funds with the benefit of considerable leverage of R&D expenditures to address wider industry problems," he said.

Since its inception ACARP has grown from strength to strength thanks to the contribution of its people who volunteer their expertise because they're passionate about the program. Bruce Robertson remains a champion.

"ACARP is one of the best things that I've ever been associated with in terms of satisfaction. Almost everything you put in generates value and interest, and is of benefit to the industry. I can't remember us ever having a bitter fight or protracted argument. There has been some robust debate from time to time with board members but we have generally worked very well together as a team," he said.

"There is no other example like ACARP in terms of industry-funded research, and the critical issue of representation is envied by everyone that I speak to in the technical and research world. It's unique and valuable.

The Australian coal industry's research program, ACARP, is unique. There's no other example of a collaborative, industry-funded program that has 100 per cent support from its constituency and produces world-class research that solves real problems. It's relevant, it's focused, it's cost-effective and it's rapid. It's also responsive to industry needs.

People, Passion and the Pursuit of Excellence – 20 Years of ACARP is a celebration of the contribution our people have made to solving critical problems around safety, the environment and the cumulative impacts of mining, as well as advancing our international competitiveness.

ACARP is successful because the professionals who volunteer their time are passionate, committed and believe in the program. It's our industry. We drive it. We make it happen. We want to make it better. If it's safer, greener, more productive and you have a good time doing it, why wouldn't you?

My involvement in ACARP began in November 2005 when I was approached by a group of junior mining companies who wanted a representative on the board to reflect the views of the small to mid-cap miners. Larger shareholders also wanted greater technical input into the research program from a board perspective and I have a dual science degree in geology and chemistry. In December 2006 I was appointed chairman.

During my time on the board I have overseen a change management program to provide clarity around the role of the board, the research committee and the technical committees, and the connections between each group.

I believe sorting out the strategic issues has fully empowered the committees and their members – the V8 engine if you will – to get on and do what's required. Our meetings have become more effective and there's a much healthier debate about the issues.

I have also seen a marked improvement in getting the results of our research reports out to our members and, through our upgraded website, we've made our reports available to a broader audience.

I continue to participate in ACARP because I enjoy it and I believe it makes a difference.

I would like to congratulate our committee members for their efforts and applaud their performance over the past 20 years. I look forward to seeing more of our younger professionals participating alongside our experienced members so we can remain the world's most successful coal research program.

Rob Neale
Chairman, Australian Coal Research Board


"If it's safer, greener, more productive and you have a good time doing it, why wouldn't you" ... Rob Neale on site at New Acland Mine.

AN EXECUTIVE PERSPECTIVE

The selection of executive directors for Australian Coal Research Ltd has reflected the distinct phases of ACARP's history. The first executive director, Ross Graham, was a passionate and energetic man, appointed from outside the industry to guide the program through its turbulent early years. Once the industry was convinced of the value of ACARP, it moved into a consolidation phase under the leadership of Ross McKinnon, a highly regarded 'son of the coal industry' with expertise in governance and coal research programs. When Ross retired in February 2005, he handed over the reins to Mark Bennetts who brought a fresh management approach to the program, underpinned by his technical background.

Ross McKinnon (left), Mark Bennetts and Ross Graham (right) share their experiences at the helm of Australian Coal Research.

A BAPTISM OF FIRE

ROSS GRAHAM EXECUTIVE DIRECTOR, OCTOBER 1991 TO JUNE 1998

My introduction to ACARP was really a baptism of fire. I was brought in while negotiations were still under way with the federal government and everything was in turmoil. However, it was very clear from the outset that the industry as a whole did not support the program. It finally secured agreement from the Australian Government and signed the MOU, which stipulated the program would run for at least three years. The industry wasn't confident about the three years, they didn't want to pay the levy of five cents per tonne and they basically thought the NERDDP research was useless. The situation was made even more difficult by the low coal prices prevailing at the time.

The Australian Coal Association (ACA) had recently been through a major restructure. It had gone from having a big budget and full-time staff to having a small budget and no staff. The ACA existed only when the Queensland Mining Council and the New South Wales Coal Association wanted to put out a joint communiqué on ACA letterhead. In fact, when I came on board I was the only employee and I had a lot of difficulty getting resources because the industry didn't want to build up the ACA again. However, it was a big job and I couldn't do it on my own. After lots of pleading, bargaining and negotiating, they gave me an offsider, but they wouldn't give me a secretary despite all the paperwork. Eventually they relented and let me share a secretary with a project group arguing for privatisation of coal-haul rail transport in New South Wales.

It was pretty difficult getting the ball rolling and the board was starting to lose patience. On one occasion they sat me down in the coal association office for about six hours and grilled me. I had to do some fast talking, but they said: "If you want to stay in this job, you'd better get a research round under way immediately and get some projects granted." That was all well and good but we had no idea how to do it. However, we had the previous committee structure of NERDDP so we replicated that. Bruce Robertson was a tower of strength. He basically said: "Let's just start and see what happens. We'll advertise for projects, bring the committees together, select the projects and go through the process." One of the real headaches was trying to figure out how much money we actually had available for research because it was still in various NERDDP accounts.

There was some initial conflict with some of the bigger coal companies who had their own research programs with their own laboratories and big budgets. So I went to talk to them. As a result of this process, ACARP decided that if its research was going to be meaningful it had to solve problems of relevance to the coal pits and we wanted them to start bringing their problems to us. We ended up with tremendous grassroots support from the industry. We had 100 or so senior managers in the system looking for new ideas. We had overseas delegations to South Africa and the USA to bring back ideas. They stopped being passive. The other contributing factor to this change in attitude was the closure of all the coal research programs around the world. If ACARP wasn't going to foster this research, who was going to do it? If we wanted coal technology in this country that suited our conditions, we'd have to create it ourselves. If we wanted the industry to grow, we had to continue our research program and train people to come into the industry.

So there came a realisation that ACARP was not a burden, but an asset. I think the timing of my departure was important because it precipitated the industry taking ownership of the program. Bringing in Ross McKinnon was brilliant because he was well known in the industry and would be able to lead ACARP through its next phase.

ACARP was one of the best things I have ever been associated with and I really enjoyed the experience despite all the challenges. The people I worked with were fantastic. I was sad to leave although I'm still convinced that it was the best thing for ACARP.

INCREASING INDUSTRY OWNERSHIP

ROSS MCKINNON – EXECUTIVE DIRECTOR, JUNE 1998 TO FEBRUARY 2005

My first involvement in ACARP goes back almost to the beginning, just after the program was approved by the Australian Government. Executive Director Ross Graham and ACA Research Committee Chairman Geoff Oldroyd came to see me in a consulting capacity to help them develop a process for allocating the research funds. They knew how much money they were going to get in, but they weren't too sure how they should spread the money across the committees.

I had no more involvement with ACARP until June 1998 when I was called to a meeting in Chris Rawlings' office. Chris was on the ACR Board. They wanted someone from outside the program to review the management of ACARP, and I accepted the task. I don't know if they specifically said so at the time, but it became clear during my review that there was very questionable support for ACARP's continuation.

It was a much easier task coming in after five years to review what was going on than having set the program up in the first place. Coming in from the outside, I had an opportunity to find out what people were really thinking. I did find that there were some positives about ACARP as well as some opportunities for improvement. Much had been achieved through industry ownership of the program in terms of better outcomes, better results and more cost-effective returns for industry.

However, I felt a different structure – more centrally located and focused – could better support the key drivers of the program and achieve a more cost-effective outcome. The result was a new structure more closely aligned to industry representation at all levels, with some changes of emphasis to internal processes. This increased ownership of program commitments by industry participants through their technical representation. AMIRA no longer managed the program. It was replaced by Roger Wischusen's company Australian Research Administration. The board of directors had become more engaged by establishing a program vision and methodology, and articulating how they functioned in relation to the research and technical committees. There was also reduced administration costs by outsourcing some tasks, cancelling redundant activities, and improving communication with federal and state authorities.

As part of this process, I sat down with Roger and talked about what he and his team would do. It was clear that dealing with the board, governance issues, secretarial responsibilities and talking to the CEOs of individual companies would be undertaken by the executive director. The day-to-day program activities would be managed by his team.

When I came on board as Executive Director, one of the key issues I tackled was extension of the program. Two-year extensions were inadequate and encouraged a short-term focus. I wanted a five-year commitment from the industry. Initially some of the directors really struggled with this idea, but we put forward a vision to them of supporting longer-term programs and introduced the concept of landmark projects – large, important research that would be undertaken over several years with bigger budgets, such as longwall automation. I was successful in getting two five-year commitments from the board, and I felt that was important. Before we went for the second extension, I commissioned ACIL to do an evaluation of the program, which showed the ongoing value of ACARP to the industry.

To instil some internal discipline into the project selection process, we decided to withhold 10 per cent of the funds allocated to each of the technical committees and hold it in reserve for the research committee to allocate. This meant that the technical committees had to compete for the balance of the funding and we found that to be quite successful.

I enjoyed my time with ACARP; I thought it was fantastic. I felt the program matured over this period. It went from being a defensive means of wresting control of industry research from the federal government and a program that lacked widespread internal support to becoming something the industry owned and had built. There was good rapport from the board down, right from the start. Everyone felt the program was theirs and they were really getting value out of it.

A CHANCE TO MAKE A DIFFERENCE

MARK BENNETTS – EXECUTIVE DIRECTOR, JANUARY 2005 – CURRENT

I was working on the Queensland Government's Smart State initiative, developing policies and technology programs and running two venture capital funds when I was approached by a previous ACR Board member to apply for the role of Executive Director. I was interested in this role because it represented a great opportunity to manage a world-class research program that improves people's lives. There aren't that many jobs around anymore where you get to make a difference.

As ACR Executive Director, I'm also the company secretary, so I carry out the main administration functions, including the management of the board and meetings as well as administrative processes including budget, audit and government relations. Terry Reilly collects the coal levy and manages the day-to-day financials.

An important part of my role is to keep CEOs and other company representatives up-to-date with our progress and to help them see the value that ACARP provides. The program is renewed every five years so if even one company says it's not participating, it could mean that the whole program falls over and we go back to the way it used to be.

There have been quite a number of changes over the past seven years. For example, there's much better synergy between the board and the Research Committee and that's partly because there are more common members between the groups. When I started, most of the board was represented by company CEOs; now there are more senior technical officers, which means they are usually closer to the technical issues at their mines.

Our communication activities have also matured. The board has supported a greater use of the internet as a communication vehicle. We re-engineered our communication strategy so that we were engaging with the right people in the right way, and used our website to get more information out there.

The focus of research has grown over time to encompass social licence to operate issues, which seem to keep mounting as a result of higher community expectations, subsequent government pressure and the companies' own values and aspirations to do better. ACARP has been running for 20 years now and the technical issues have become more manageable over time because of previous research and better technology, but the social impact side of things keeps growing. It's not going to go away so we have to be proactive and deal with these issues sensitively as they arise within the community.

The glue that keeps ACARP together is its board and committee members who volunteer their world-class expertise because they see the value in it, not only for their business but for the industry at large. These people are the heart and soul of ACARP and if it wasn't for that generosity of spirit, ACARP simply would not exist.

REVOLUTIONISING COAL PREPARATION

An Australian invention that increases the amount of usable coal from the coal preparation process is now being taken up around the world.

The Reflux Classifier represents a step change in performance, particularly at low separation densities and has revolutionised coal preparation in Australia, according to ACARP Research Coordinator Peter Newling.

This unit can do three things – it can separate the coking coal and thermal coal fractions from the fines product; it can separate coal at a much finer size than spirals; and it can also produce lower ash at the same yield in fine coal.

“These advantages to the coal industry are absolutely huge,” Peter said.

“There are millions of dollars of coal still being thrown away that could be relocated to product coal by installing these machines. Process engineers are also finding other uses for these units such as re-treating flotation cell tailings, which can make millions of dollars a year and reduce energy intensity.”

Developed by Kevin Galvin at the University of Newcastle, initially funded by ACARP and commercialised by Ludowici, the Reflux Classifier is a fine-coal separator incorporating a system of inclined channels above an autogenous dense-medium fluidised bed.

Kevin said the idea for incline settling was adapted from directional drilling in the oil industry. On a trip to Houston he observed operators changing the angle of a test rig.

“It was incredible to see and I thought there must be a way to use that process to classify particles. Sometime later I became involved with a project led by Stuart Nichol on teetered bed separators. The Reflux Classifier is really a combination of these two technologies,” he said.

“One of the key issues in demonstrating this concept was to determine how to scale it up to an industrial-sized system. The solution was to have an array of inclined plates sitting above a fluidised bed. Having the plates close together produces a laminar shear condition, which helps to convey particles up through the channels. The first particles to be conveyed are the low density ones.”

Like most ACARP projects, site support is critical to success and Bloomfield Collieries – renowned innovators in their own right – agreed to trial the pilot Reflux Classifier at its Bloomfield operation.

“My father Paul always had a passion for coal prep and I inherited that. Kevin showed us a very simple demonstration and it was illuminating to us,” said William Cant (previous MD of The Bloomfield Group) .

“They wanted to build a pilot-scale unit, so we assisted in giving them a section of our plant to play with. We were just in the process of upgrading the plant to wash coal from the neighbouring Donaldson open cut mine and we were looking for increased capacity and a better processing technique.”

Following the installation of a full-scale unit at Bloomfield, Paul, William and their team identified a method of better managing colloidal clays, which don’t separate well.

“We were able to develop some technology to get almost all the colloidal clays or slimes out of the feed to the Reflux Classifier and it really made it shine. All the coal just lit up and it processed a lot better. We implemented that technology at both plants and kept tweaking it,” William said.

Demand for the Reflux Classifier continues to grow rapidly with units ordered for installation across New South Wales, Queensland and around the world.

"These advantages to the coal industry are absolutely huge. There are millions and millions of dollars of coal still being thrown away that could be relocated to product coal by installing these machines."
- Peter Newling

Kevin Galvin at the University of Newcastle laboratory.

COAL PREPARATION

THE “CAN DO” CANTS – COAL INDUSTRY INNOVATORS

William Cant

The Cant family’s connection with coal mining in the Hunter Valley spans four generations, from Alexander Reid Cant who was General Manager at the Dudley Coal Company to William Cant who retired from the family business Bloomfield in 2010.

William’s grandfather Roy Alexander Cant bought the Bloomfield coal mining lease at East Maitland from the Beattie Brothers in 1934. Hand mining was carried out at the Bloomfield pit until after World War II when mechanisation was introduced.

“In those days the equipment was very primitive, so my father Paul was always pulling things to pieces and making them better; tweaking and prodding for better efficiency – and that has remained a family philosophy,” William said.

In fact, the Cant name has become synonymous with innovation.

“With the expansion of Rix’s Creek, we couldn’t afford to buy a new excavator. We had a dragline, which was redundant to our purposes, so we turned it into a ‘dragascavator’ – at that time, one of only three draglines in the world being used to load trucks,” William said.

“We mucked around with boom angles and boom lengths, dumping radiuses and all sorts of things to increas its productivity from 400 metres an hour as a dragline to 900 metres an hour as a dragscavator.

In searching for the optimum bucket for their Hitachi 3600 excavator, the Cants were the first operators to model excavator swing and dump.

“In terms of tyre life, we were getting 16,000 hours from some truck tyres when I left Rix’s Creek.

“In coal preparation, we used sieve bend technology to handle clays, which made the Reflux Classifier sing, and we were able to reduce our magnetite consumption to 0.4 kilograms per ROM tonne.

“My father and I used to operate by gut instinct. When we had a problem we would always have a go at fixing it, and we did. When you start kicking ideas around, people’s eyes light up. When you inspire people and allow them to be creative, their employment and performance in their job increases dramatically. Our people are our greatest asset, we just have to encourage them.”

Peter Newling and his prized cellar.

Peter Newling, ACARP Research Coordinator for the Coal Preparation Committee, has been a keen supporter of the Reflux Classifier.

Although fondly regarded as the doctor of coal prep in Australia, Peter Newling started his working life as a chemical engineer at Newcastle Steelworks

After returning from South Africa in 1981 where he had worked for five years, Peter traded in that hot, hazardous environment of blast furnace operations for the volatile industrial relations environment of the Australian coal industry.

He has worked in a range of senior plant management roles at operations across New South Wales, including at Hunter Valley No 1, Wollondilly, Stratford and Katherine Hill Bay. He has tackled industrial relations and environmental issues head on; brought new plants online; turned around old, run-down, inefficient plants with low availability; introduced leading-edge technology; optimised complex plants; and gone head-to-head with the Maritime Union of Australia; but he holds his safety record as his greatest professional achievement.

"I've had a really good record with safety everywhere I've worked. The last two jobs I had would have stretched over 12 years and I guess I would have had employees lose four days over that period – so I'm pretty pleased about that," he said.

After his role at Katherine Hill Bay, Peter established his own consultancy which takes him around the world, and became the ACARP Research Coordinator for the Coal Preparation Committee.

Over his career he has witnessed remarkable change across the industry – plant capacity has jumped by almost a factor of five; dense medium cyclones have grown from 0.7 metres to 1.5 metres in diameter; big shutdowns at Easter and Christmas have all but vanished; and automation has been widely introduced.

Peter is involved in the Coal Prep Society, is a past chairman of the NSW branch and was editor of one of its monographs.

He and his wife Anne live on the shores of Lake Macquarie, an idyllic location for visiting grandchildren. Their home also has a cellar, excavated by Peter himself and home to an impressive collection of red wine.

A SEISMIC SHIFT IN COAL EXPLORATION

Within two decades 3D seismic has gone from being an expensive, 'out there' concept applied mainly in the oil and gas industry to a valuable, common practice used to define coal resources and to understand the associated geological conditions.

Unlike the oil and gas industry, which uses 3D seismic surveys to define resources at depths typically greater than one kilometre, the coal industry needs much more detail to identify geological features at depths less than one kilometre. Significant work, much of it funded by ACARP, was required to adapt the technology and improve the resolution. More recently, 2D and innovative 3D surveys that record the conversion of 'compressional waves' to 'shear waves' has allowed surveying at shallower depths, even into the base of weathering.

Seismic surveys fill in the geological information between exploration drill holes. 3D seismic surveying allows the generation of maps of the subsurface layering in three dimensions. 3D seismic results enable mines to be designed in full consideration of geological structures such as faults, folds and igneous intrusions. Having an accurate picture of the geological conditions is particularly important in underground mines. It makes mining less hazardous and reduces costs, particularly if a longwall needs to be relocated.

Anglo American's Metallurgical Coal business Regional Manager Resource Assessment Andy Willson said 3D seismic offered significant advantages over traditional exploration methods such as drilling boreholes."Typically we drill boreholes down to about every 250 metres. When we shoot 3D seismic, we're

Doug Dunn and Andy Willson using 3D seismic to design safer mines.

Doug Dunn explains the advantages of using 3D seismic.

getting data points where we are testing the surface every 7.5 metres and we can see features that we would never have picked up with the drilling, not just obvious faults," he said.

"We identified a monocline roll at Moranbah North which we would never have seen with drilling, but you can see that increase in dip very clearly on the 3D seismic. It's a fantastic tool, no doubt about it.

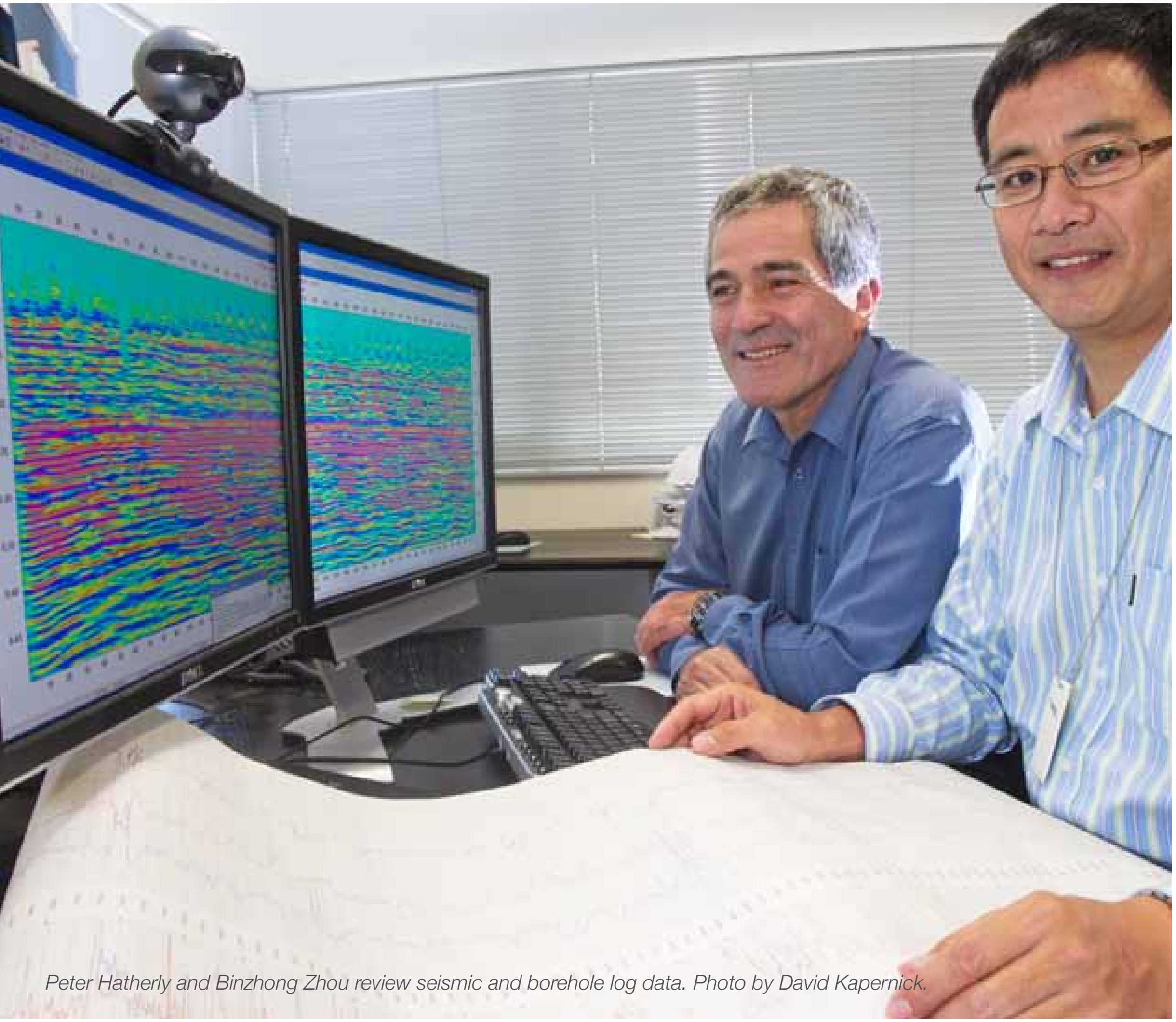
"By doing seismic and reducing the number of drill holes, we can reduce our overall exploration expenditure and get a better result."

BHP Billiton Mitsubishi Alliance Senior Manager Geological Services Doug Dunn said 3D seismic surveying had become integral to BHP Billiton's feasibility study and resource estimation processes.

"Across our business, resources for underground mine projects cannot move from 'indicated' to 'measured' confidence without 3D seismic coverage. This flags the fact that there's a structural risk, which might impact project economics. You can drill as many holes as you like but unless you've got 3D seismic it will never become a proven reserve," he said.

SEISMIC TECHNOLOGY

RESEARCH DELIVERS INNOVATION AND BUILDS SCIENTIFIC KNOWLEDGE



Peter Hatherly and Binzhong Zhou review seismic and borehole log data. Photo by David Kapernick.

The healthy symbiotic relationship that exists between ACARP and its researchers drives technological innovation while building scientific capacity.

Coal mining companies don't usually employ geophysicists, but this expertise has been integral to the development of reflection seismic and microseismic surveys. By supporting the program of seismic work over the past 20 years, the coal industry has helped to build research capacity in this field, which returns dividends in the form of ever advancing technology that is being applied across the industry.

"Because ACARP exists, it is possible for people like us undertake research in this area. If we weren't doing this work, the coal industry probably wouldn't be using seismic because no-one would have taken those first steps in adapting it from the oil and gas industry," said consultant Peter Hatherly, who has been a senior researcher with CSIRO and CRCMining.

This program of work has also helped geophysicists such as CSIRO's Binzhong Zhou and Xun Luo to apply their knowledge across a range of practical industry issues. Both were seismologists with no industry experience when they first came on board.

"Theoretical investigations are quite different from industry-based research, which must deliver practical outcomes. Over time, we have gained a much better understanding of industry's requirements," Binzhong said.

A major achievement in seismology in Australia has been the successful adaption of microseismic from the hard-rock environment to coal, thanks to initial input from Englishman Peter Styles, former CSIRO scientist Cliff Mallet and others. Microseismic is a passive means of understanding ground response to the mining process. Seismic energy is naturally generated from sudden stress releases due to rock fracturing. Sensors are deployed in the ground and on the surface to identify the energy source, its location, timing and type of failure. This process can be used to determine the extent of the fracturing above and below the mining horizon. It can also be used to identify other hazardous conditions including emissions of gas into workings, roof failures, excess loading of longwall supports, periodic weightings and windblasts.

Peter Hatherly and his team undertook the first microseismic trials at Gordonstone coal mine (now Kestrel) in 1994, which proved successful, thanks in large part to the Gordonstone team.

“If you don’t have site people willing to support experimental work, to try something different and to put a bit of time into helping us do our work, we wouldn’t get results. I relied on support from geologist Derek Devy who organised drill rigs and set things up all outside his normal operational duties. I think the willingness of the industry to contribute to any initial experiments is a very important factor,” Peter said.

Since the Gordonstone trials, microseismic technology has progressed in leaps and bounds.

“Through ACARP support, our microseismic technology is leading the world in risk management and production control in longwall mining,” Xun said.

“There is interest from industry to use this technology for risk management and production control and we have also expanded its use into highwall stability in open pit coal mines and hydraulic fracturing in the coal seam gas industry.”

In 1998 Peter Hatherly and the CSIRO team, including mining engineer Mick Kelly and geotechnical consultant Winton Gale, won an ACARP Excellence Award for their work on the development of microseismic methods and their integration into numerical modelling for better understanding of longwall geomechanics.

Xun Luo with geophone sensors for microseismic monitoring. Photo by David Kapernick.

WORKPLACE HEALTH AND SAFETY

EQUIPMENT SAFER BY DESIGN

Substantial improvements to the design of mining equipment have helped reduce the risk of injuries to Australian underground coal miners.

The world's most comprehensive analysis of underground mining equipment-related injuries was undertaken by ergonomist and researcher Robin Burgess-Limerick from 2004 to 2010. It provided manufacturers with the information they needed to improve equipment design and enabled mining companies to understand the health and safety risks inherent in buying that equipment.

The need for this work was identified by Dave Mellows, former Xstrata Coal NSW Group Safety Manager who was concerned about the high injury rates associated with underground equipment.

"In 2003 when we became Xstrata Coal we started to develop our systems and improve our safety performance. We had some big wins in those first couple of years – we halved our injury rate – but it became painfully obvious that our undergrounds were not improving at the same rate as the open cuts," he said.

"When we looked at the statistics, the undergrounds lagged 10 to 15 years behind the open cuts in the development of machinery ergonomics and that the injuries were concentrated around roadway development activities and employee transport."

Dave recognised this issue required an industry-wide response and made application for ACARP funding, having approached Robin Burgess-Limerick for assistance. The project was initially funded directly by Xstrata Coal until the ACARP project was approved the following year. Over the next six years, ACARP funded three projects that helped make substantial improvements to the design of mining equipment.

Following the Xstrata work, Robin analysed more than 8000 injuries reported to NSW Coal Services between June 2003 and June 2008. He and fellow researchers Suzanne Johnson, Gary Dennis and Jenny Legge systematically identified the hazards associated with underground mining equipment and collated controls being used through site visits to Ulan, Beltana, United, Baal Bone, West Wallsend, Oaky North, Kestrel, Dartbrook, Dendrobium, Metropolitan, Angus Place, Newlands and Appin. Robin also visited manufacturers, government agencies and international research organisations to identify potential controls for outstanding injury risks. The practical outcomes from this work documented best practice in the control of injury risks associated with underground coal mining equipment. In 2006 Robin accepted a six-month assignment as National Academy of Sciences Research Associate with the National Institute for Occupational Safety and Health (NIOSH) in Pittsburgh USA to collaborate with Lisa Steiner and others. In 2007 the research won an ACARP Excellence Award for reducing injury risks associated with underground mining equipment.

During this initial work, a knowledge gap was identified regarding appropriate principles for designing controls such as those used in roof and rib bolting. To bridge this gap a series of experiments was undertaken in collaboration with Guy Wallis and Masters student Veronica Krupenia from the University of Queensland and Lisa Steiner from NIOSH. The results were incorporated into the NSW Mining Design Guideline 35.1 Guideline for Bolting and Drilling Plant in Mines.

Robin said over the past eight years great improvements had been made to the design of equipment such as loaders and continuous miners.

"The improvements have come about through genuine collaborations between manufacturers and mining companies and, in particular, through manufacturers engaging with the operators of mining equipment to learn from their valuable experiences. Ergonomists and human factors professionals have also played an important role," he said.

"The next challenge is to automate the bolting process and remove miners from the development face through non-line-of-sight remote supervision of the continuous miner. This is an area in which ACARP funding has also been driving improvements, primarily through the Roadway Development Task Group."

Continued over page

Centennial Coal Chief Risk Officer John Hempenstall was an industry monitor on some of these research projects.

“Repetitive strain injuries are prevalent in the underground mining environment, particularly around roof-bolting and the operation of mining machinery. This research has delivered an improvement in ergonomic standards that original equipment manufacturers should be applying,” he said.

“Robin’s research is first class. He listens to what industry tells him the problems are and identifies appropriate solutions.”

Sandvik Product Line Manager Alan Bruce said his team had been working to improve the ergonomics of his company’s underground equipment.

“Over the past seven years there’s been a big difference to our machines and these changes have been driven by industry,” he said.

“We’re working with our customers to achieve the same goal. They come in, we sit down and discuss the issues and try to nut something out.”

“The improvements have come about through genuine collaborations between manufacturers and mining companies and, in particular, through manufacturers engaging with the operators of mining equipment to learn from their valuable experiences.”
- Robin Burgess-Limerick

Dave Mellows and Robin Burgess-Limerick examine the ergonomic improvements on Sandvik’s machinery, which have reduced the risk of injury to operators.

MANAGING GEOTECHNICAL RISK

SCIENCE DISPELS THE GEOTECHNICAL MYTHS OF UNDERGROUND MINING

A dramatic improvement in underground coal mine safety and effective management of geotechnical risk has been driven by consistent, world-class research over the past 20 years.

The Australian coal industry leads the world in rock bolting, cable bolting, longwall face support specification, pillar design, computer modelling of underground coal mining, management of water inflow around longwall panels, and a host of other practices. In fact, we export our expertise to the Europeans and the Americans.

Winton Gale and Jim Galvin grapple with a better understanding of strata to make mining safer.

"Australia has developed into the safest and most technologically advanced coal mining industry in the world," according to Jim Galvin, industry identity and Emeritus Professor at the University of New South Wales.

"ACARP's strategic and sustained commitment to basic and applied research has contributed enormously to this success. Nowhere is ACARP's contribution more evident than in ground control, where eliminating fatalities and injuries due to falls of ground is approaching fruition. This is all the more remarkable because mining takes place in an environment where rock failure is deliberately induced as part of the extraction process."

The harsh, challenging underground environment has resulted in underground workers becoming acutely aware of mining conditions and quite intuitive about changes to those conditions. These days science provides a clear understanding of what is happening underground and a suite of tools to manage those conditions.

Strata control is one of the principal hazards in underground coal mines, according to Dan Payne, BHP Billiton Mitsubishi Alliance Manager Geotechnical Services.

"In most ground control related decisions, geotechnical engineers have the responsibility to predict and control the effect mining will have on ground behaviour and safety. Therefore, the more scientific and quantifiable tools they have to assist with designs and validate the 'gut feel' and local experience, the better," he said.

"Research has added to the geotechnical toolbox and helped us to better understand strata and how it's going to behave."

It's no coincidence that Australia has one of the safest, most productive and technologically advanced coal industries in the world – it is underpinned by the largest and most successful industry-funded and managed coal research program.

As national coal research centres around the globe close their doors, there has been a tangible impact on the performance of our nation's coal mining competitors.

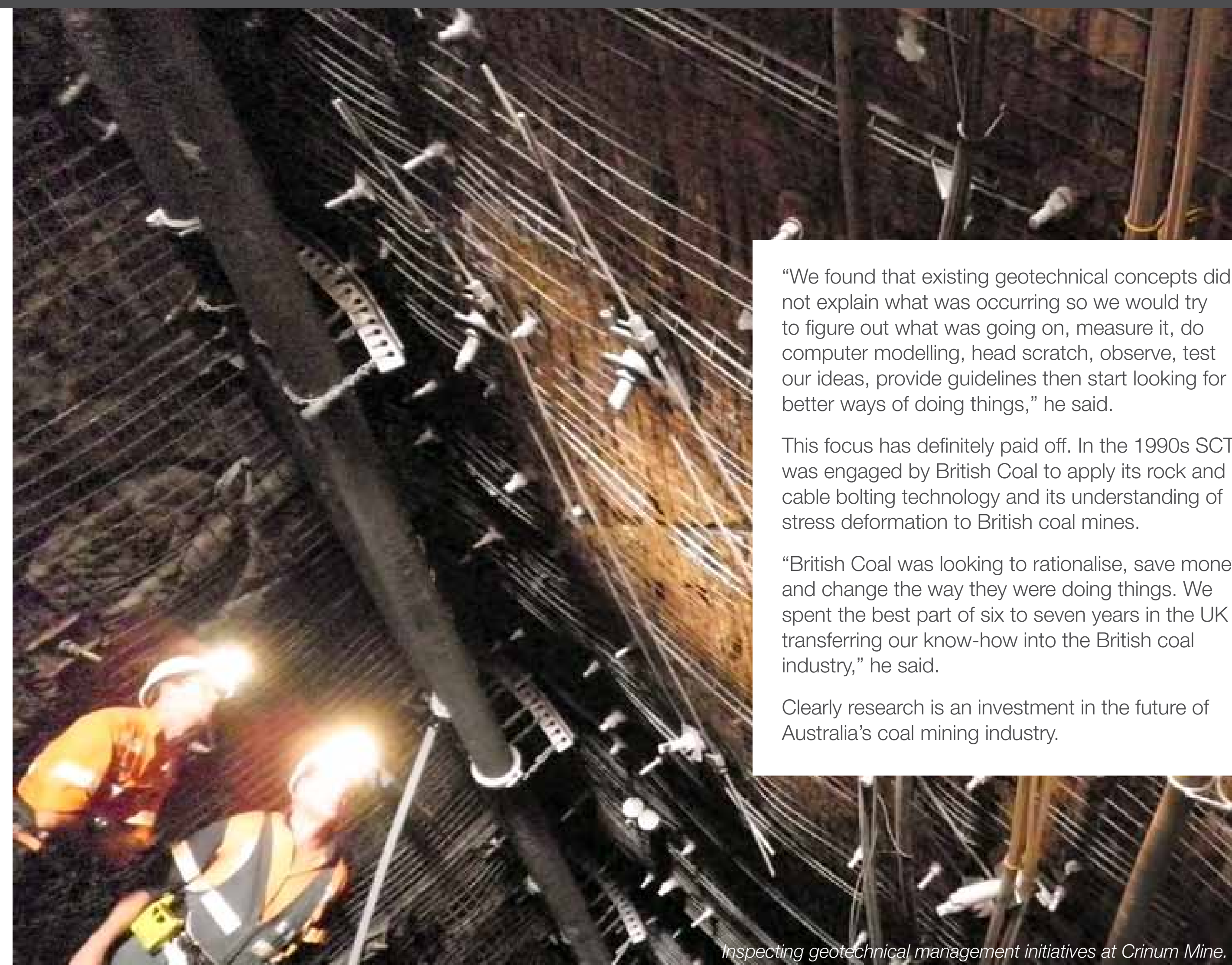
Strata Control Technology (SCT) Director Winton Gale said despite initially importing its underground mining 'know-how', Australia now led the world in many geotechnical practices.

"In the late 70s the French and the USA were way ahead of Australia in roof bolting, for example, but they dropped the ball. The funding stopped, the researchers left and the research stalled," he said.

"We picked this technology up in 1983 and have been continuing to develop it ever since; we now lead the world.

"To remain at the cutting edge of coal mining technology you need to have a sustained culture of investment in research and applying science to industry practices. You can't just turn research on and off with financial whims because it never recovers. Researchers need to work continuously on issues to make the breakthroughs."

Winton said over time Australia's researchers had become more sophisticated in their approach to addressing geotechnical issues.



Inspecting geotechnical management initiatives at Crinum Mine.

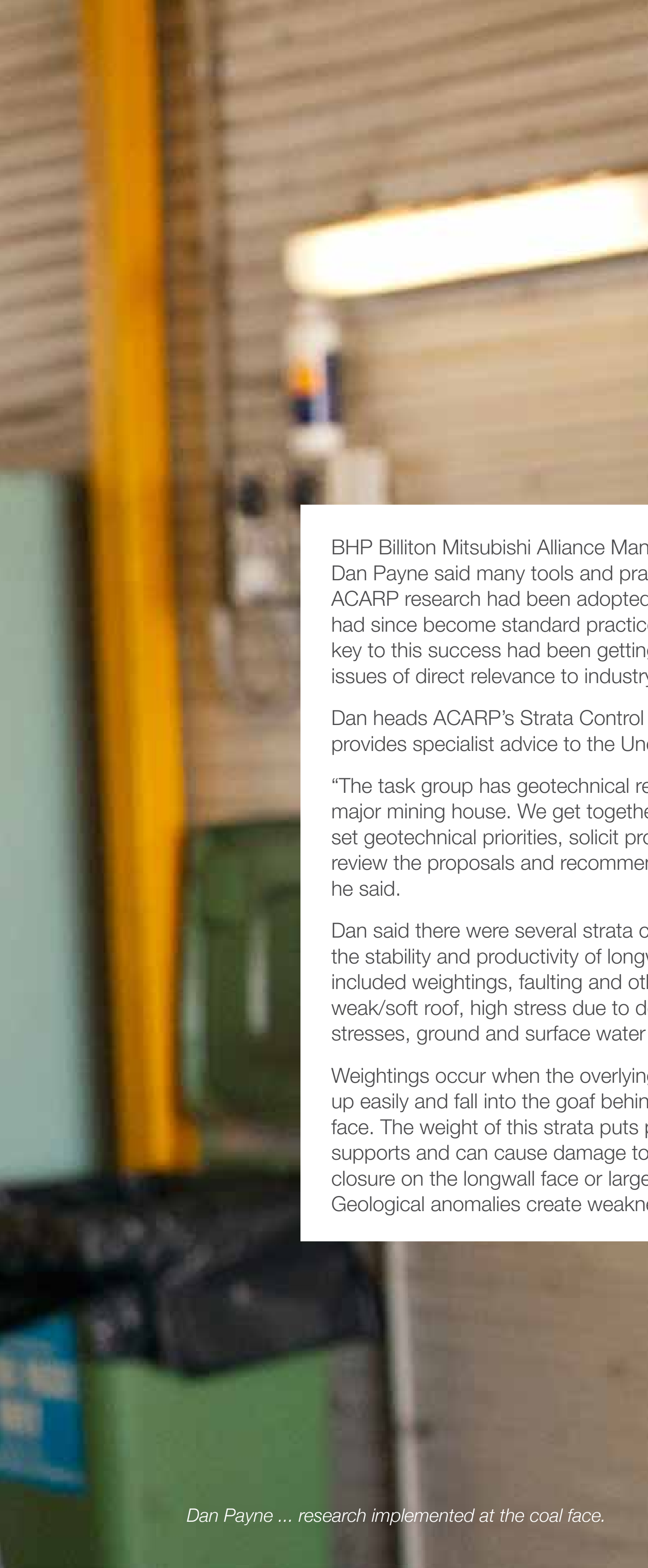
"We found that existing geotechnical concepts did not explain what was occurring so we would try to figure out what was going on, measure it, do computer modelling, head scratch, observe, test our ideas, provide guidelines then start looking for better ways of doing things," he said.

This focus has definitely paid off. In the 1990s SCT was engaged by British Coal to apply its rock and cable bolting technology and its understanding of stress deformation to British coal mines.

"British Coal was looking to rationalise, save money and change the way they were doing things. We spent the best part of six to seven years in the UK transferring our know-how into the British coal industry," he said.

Clearly research is an investment in the future of Australia's coal mining industry.

"ACARP project approval is a democratic system where we select, fund, monitor and implement research which benefits the entire industry."



Dan Payne ... research implemented at the coal face.

FROM THEORY TO PRACTICE: RESEARCH IMPLEMENTED AT THE COAL FACE

Geotechnical best practice developed from world-class research has been embraced by the Australian coal industry, successfully bridging the gap between research results and mine site implementation.

BHP Billiton Mitsubishi Alliance Manager Geotechnical Services Dan Payne said many tools and practices resulting from ACARP research had been adopted by mining companies and had since become standard practice across the industry. A key to this success had been getting researchers to focus on issues of direct relevance to industry.

Dan heads ACARP's Strata Control Task Group, which provides specialist advice to the Underground Committee.

"The task group has geotechnical representation from every major mining house. We get together three times a year to set geotechnical priorities, solicit proposals from researchers, review the proposals and recommend projects for funding," he said.

Dan said there were several strata control issues that affected the stability and productivity of longwall mines. Some of these included weightings, faulting and other geological structures, weak/soft roof, high stress due to depth or horizontal tectonic stresses, ground and surface water inflow, and subsidence.

Weightings occur when the overlying strata doesn't break up easily and fall into the goaf behind the retreating longwall face. The weight of this strata puts pressure on the longwall supports and can cause damage to the supports, excessive closure on the longwall face or large roof falls at the face. Geological anomalies create weaknesses in the normally continuous rock mass and result in instability and roof falls when exposed. Soft roof and areas of high stress are also difficult to control when the stress exceeds the ground strength. In this case, the ground around the opening will fail. These areas require an increase in the capacity of roof support and adequate pillar design. Significant amounts of water can flow into the mining area when the effects of the caving ground behind the longwall create fractures that extend up to overlying aquifers or surface water bodies. This can result in flooding of the mine and environmental concerns. The extraction of coal also leads to subsidence on the surface, the extent and location of which must be managed particularly in areas of sensitive surface environment or infrastructure.

Given this challenging environment, cutting-edge research remains critical to managing geotechnical risk in Australian underground coal mines. According to the task group, key results are making a fundamental difference to the way mines operate, including a systematic approach to pillar design, roadway roof stability and its attainment through pre-tensioned bolting, chain pillar design, performance evaluation of flexible roof bolts and prestressing of strands to improve cable performance, and caving behaviour studies.

"ACARP project approval is a democratic system where we select, fund, monitor and implement research that benefits the entire industry," Dan said.

ACTIVE EXPLOSION BARRIER

WORLD-CLASS MODELLING LEADS TO MINE SAFETY BREAKTHROUGH

With some of the best brains in the business onboard, many months of computational fluid dynamics (CFD) modelling using a mini supercomputer, identification and use of hundreds scientific equations, and an investment of more than $1.5 million over eight years, the Australian coal industry is on the cusp of a critical breakthrough in underground mine safety.

Researchers from SkillPro and BMT WBM have developed a prototype water-based active explosion barrier to suppress the flame front of an underground mine explosion, limit the extent of the explosion as close as possible to the working face and minimise loss of life. The effectiveness of the prototype will be tested at CSIR's 2.5-metre diameter, 200-metre long Kloppersbos explosion testing facility in South Africa.

"If this active explosion barrier saves just one life it will have been worth it," said ACARP Research Coordinator Bevan Kathage.

"In developed countries ignitions happen rarely but they are usually catastrophic. The explosion barrier puts another line of defence in the system in addition to stone dusting. It means we can contain an ignition to a face area and stop it from going through the mine. This allows other workers to escape and permits mine re-entry.

"This world-first, cutting-edge research has produced an explosion barrier that is so simple; it's not reliant on a complicated set of elements working together at the same time."

The prototype has a flame detector inbye of the explosion barrier, a pressurised vessel to store water, and two metal spray bars with around 180 nozzles. When the flame is detected, an electric signal opens a valve at the bottom of the pressurised vessel releasing up to 240 litres of water in a quarter of a second. A fine water spray is injected at great speed into the roadway to stop combustion and suppress the flame front. The size of the water droplets – around 130 microns – is much smaller than those in a conventional water barrier and is more effective at absorbing heat.

SkillPro Principal Consultant David Humphreys said the use of CFD had been integral to establishing a set of operational requirements for the prototype.

"CFD is a powerful tool that allows you to simulate very complex, non-linear events such as coal dust explosions. Using the database we had compiled of coal dust explosion behaviour in the Kloppersbos tunnel, we were able to develop a CFD model over a wide range of conditions," he said.

"That got us to the point where we believed we had a pretty good handle on the physics, chemistry, thermodynamics and heat transfer that was taking place in the tunnel and we were able to design a barrier based on scientific principles."

BMT WBM Manager Advanced Simulation Greg Collecutt, who has a PhD in computational physics, describes the complexity of simulating a coal dust explosion.

"CFD divides a volume into lots of cells and computes the flow of air from one cell to the next. It tracks the density, velocity and turbulence of the flow. In a coal dust explosion there is oxygen, nitrogen, methane, hydrogen, carbon monoxide, carbon dioxide, water vapour and heat – lots of chemical reactions that we need to simulate," he said.

"We need to track billions of microscopic dust particles as well as conserve momentum (slowing down and speeding up of the gas flow), conserve energy (heating and cooling of gas particles) and also model heat radiation."

When the flame is detected, an electric signal opens a valve at the bottom of the pressurised vessel releasing up to 240 litres of water in a quarter of a second.

Getting the model right was an iterative process. The researchers started with basic physics mechanisms and scoured published scientific papers to identify the equations needed to replicate a coal dust explosion.

Keeping the end focus in sight was integral to the project's success.

"We've always recognised that the primary goal of this project was two-fold. The first was to achieve a repeatable, successful suppression of an explosion in the Kloppersbos tunnel. The second goal was to use the data acquired during those tests to validate the CFD so that it can be used more confidently in the future for design optimisation and assessing different real world roadways and mine layouts," Greg said.

"Whenever we were stumped on an issue, we would go back to those two goals and ask whether what we were doing was working towards those goals."

David Proud, David Humphreys, Julian Greenwood, Greg Collecutt ... on the verge of a breakthrough for mine safety.

ACARP Research Coordinator Bevan Kathage has been instrumental in guiding work on the active explosion barrier project.

Bevan Kathage cherishes most the people he's worked with.

Bevan Kathage has coal in his blood.

He was barely six years old when he first went down the pit with his father Arthur, an Ipswich colliery proprietor. It was no surprise then that Bevan chose to establish a career in the coal industry albeit on his own merit rather than joining the family business, Westfailen Collieries.

Bevan completed a PhD at the University of Queensland on the prediction of temperature increases in ventilation currents in hard rock mines before marrying his sweetheart Bev and heading down to Wollongong to start his first job with AIS at Kemira. Bevan and Bev clocked up seven addresses in seven years.

With a career spanning 34 years, Bevan has worked in the Illawarra, the Hunter Valley, the Bowen Basin and the Clarence-Moreton Basin. Some highlights include: recovering an ironbound longwall face at Kemira in 1968, a pit which subsequently achieved the world's most productive longwall record (5500 tonnes in 24 hours); the growth of New Hope Corporation to seven underground mines, four open cut mines, three preparation plants and 450 employees by the time he left in 1982; driving the first drift into Gordonstone (Kestrel); participating in the Mining Warden's Inquiry into the Moura No 4 mine explosion; and assisting a local historian to interview old timers for a book on the history of the Ipswich coal mines (funded by a bequest from the owners of Rhondda Colliery).

These days Bevan is the ACARP Research Coordinator of the Underground Committee, a role he took over 10 years ago from his long-time colleague Jon Sleeman who was working for AIS at Corrimal when Bevan was at Kemira.

As Bevan recounts stories from his working life, it's clear that the thing he cherishes most is the relationships he's established with the blokes he's worked with. He misses being in the thick of it, the fun, the jokes, everyone rolling up their sleeves and getting the job done, and rising to the challenges he set.

"Maybe I miss the old world because that's where I come from, but there is a future. It won't necessarily be what people know today, but the coal industry will still be there," he said.

COALS AIN'T COALS

Australia has some of the best coals in the world. Its thermal coals are clean with very few trace elements. Its coking coals are very reactive, producing high quality coke needed for steel production. Convincing customers of these attributes requires more than just spruiking – it needs a program of targeted research and ACARP's Technical Market Support (TMS) Committee has been coordinating this work on behalf of the industry.

"This committee is a very good example of how competitors in the export coal industry work together to push the international competitiveness of Australian coals, so it's unique," said TMS Committee Co-chair Chris Dempsey, Peabody Coalsales Australia's General Manager Coal Technology – Marketing.

"To make sure we don't lose any of our market share, we need to have technical information that will convince our customers that our coal has advantages over other coals."

The members of the TMS Committee account for more than 90 per cent of the country's black coal production. The 16 members represent the total supply chain including an exploration geologist, mining engineers, metallurgists, chemists and marketers through to end users such as coke makers, steel producers and power generators.

The TMS Committee is highly responsive to emerging issues and market trends. An important issue currently under investigation is mercury exposure. Existing global mercury inventories suggest that the coal and mineral processing industries are major sources of human-induced emissions. The United Nations Environment Programme's voluntary Global Mercury Partnership is taking action to address mercury exposure issues.

Xstrata Coal Group Manager Coal Technology and TMS Committee Co-chair Barry Isherwood said although Australian coals were generally considered low in mercury content, addressing exposure was a global issue.

"As a major coal exporter, we need to be at the forefront of any technical and legal discussion, that's why we've commissioned Peter Nelson from Macquarie University's Graduate School of the Environment to keep us up-to-date and to facilitate the involvement of our coal combustion experts in the Global Mercury Partnership. Peter is considered one of the world's experts in the area of trace element emissions, such as mercury," he said.

Keeping up with changes in customer technologies and their impact on Australia's suite of coals is also critical. For example Indian steel producers have introduced stamp charging, a process that improves coking properties by increasing coal density; the closer the coal grains are together, the better they seem to bond. This technology has the potential to affect Australia's hard coking coal sales.

"We have conducted research so that we fully understand how our different coals perform in stamp charging and we've found that the performance of weaker coals are improved such that they can replace hard coking coals. That's why the Indians are investing in this technology, because they can increase the amount of cheaper coal in their oven blends," Chris said.

Over the past 20 years, the focus of research into the performance of Australian coals has changed significantly, from initial work around SO_x and NO_x, slagging and fouling to advanced microscopic investigations such as automated petrographics, which predicts coking performance based on coal grains, and coke strength based on coke samples.

"At the end of the day, the blast furnace guy wants good coke with a good coke strength otherwise it just breaks up. This technology allows us to discern why some coals provide superior coke strength compared to others," Chris said.

With some excellent research projects completed, two of ACARP's key researchers in this area, Graham O'Brien and Phil Bennett, and the TMS Committee felt it was time to share this information and showcase a range of technology successes. In March 2012 a coal science conference was presented in Brisbane which was so popular the organisers had to change venues to accommodate everyone. With around 100 people attending, there was overwhelming agreement to hold regular conferences.

The Technical Market Support Committee ... the coal industry working together.

Harold Rogers and Chris Dempsey ... keeping up with customers' needs is vital.

Barry Isherwood (centre) chats with researchers and fellow committee members.

INDUSTRY TACKLES CUMULATIVE IMPACTS OF COAL MINING

Addressing the cumulative impacts of coal mining using social science research is helping mining companies to strengthen their licence to operate.

Daniel Franks captures the thoughts of his break-out group during a meeting of the Moranbah Cumulative Impacts Group.

Cumulative impacts are the successive, incremental and combined positive and negative impacts of an activity on society, the economy and the environment. They can arise from the activities of a single or multiple operations, as well as the interaction of mining impacts with non-mining activities.

The Sustainable Minerals Institute (SMI) at The University of Queensland has undertaken three projects to address cumulative coal mining impacts. The first project was initial exploratory work in the Hunter Valley. SMI then produced the *Cumulative Impacts: A Good Practice Guide for the Australian Coal Mining Industry* which provides practical examples and frameworks. The third project used action research which is exploring the governance issues associated with cumulative impacts in the Bowen Basin. Combined, these projects have not only fostered ongoing capacity development across the industry, but among regulators, local government and NGOs in Australia, and even government officials in emerging mining nations.

Although there were challenges associated with the initial project, David Brereton, Director of SMI's Centre for Social Responsibility in Mining, and Daniel Franks, Senior Research Fellow at the centre, believe it provided a framework that mines could use to better identify their social impacts and plan strategies to manage those impacts.

"The initial scoping project was really the first time the coal industry had explored its impacts and contributions as a whole rather than as individual mines," David said.

"The project did help to bring the discourse of cumulative impacts into common speech and it helped to break down the barriers to collaboration between the mining industry players themselves and between the industry and other stakeholders."

In the second project, researchers produced the good practice guide which provided case studies as well as practical examples and methodologies on how best to deal with multi-mine impacts. Prior to its development there was no definitive or recognised work in place that offered an Australian context or guidance on the identification, assessment and management of economic, social and environmental cumulative impacts.

Stretched social infrastructure and increased amenity concerns in the Bowen Basin, particularly around Moranbah, and an advocacy push from the Isaac Regional Council was the impetus behind SMI's third project.

"We're now looking at what roles stakeholders play in a governance framework that goes beyond the regulation of individual mines, which is what traditionally happens, to a system with multiple

DERM representatives Tiffany Cook and Jacqueline Wirth at a Moranbah Cumulative Impacts Group meeting.

players and covers a catchment greater than local government but may not reach the regional level," Daniel said.

"For example, if you look at the impact of dust, it affects the local air shed, so we need to focus at that scale and get the right groups involved. If it's water impacts from saline discharge in the Fitzroy River, then we have to take a different level of analysis and a different catchment to bring those concerned together.

"There are challenges around stakeholder collaboration but there are some really practical tools that can be used in these situations, such as considering how the stakeholder consultation group is constituted, what its terms of reference are, meeting protocols, and whether to have an independent chair. All these nitty gritty issues actually make a difference to the outcome of these processes."

Not only is the Australian coal industry benefiting from the capacity the SMI is building around managing the cumulative impacts of coal mining, so are other industries around the world.

"SMI and the Minerals and Energy Institute at the University of Western Australia have received significant funding from AusAID for the International Centre for Mine Development, which is a multi-year initiative to train and improve the capacity of government people in emerging mining nations. One of the topics we will be addressing in that forum is management of cumulative impacts," David said.

COAL INDUSTRY JOINS FORCES TO REDUCE EFFECT OF BLAST OVERPRESSURE ON COMMUNITIES

By joining forces to fund, construct and manage a meteorological monitoring facility and advanced atmospheric modelling system, Hunter Valley coal mines have been able to address previously unpredictable atmospheric effects, which can amplify mine blasting impacts on nearby communites.

Rio Tinto Technology & Innovation Principal Advisor Environment Bruce Foster said in response to the need to more reliably predict this phenomenon, the open cut mines had formed a joint venture to manage the monitoring facility and provide the infrastructure support required to run the model.

"This was the very first time that anyone had set up a joint venture to collectively manage environmental matters at this scale in the Hunter Valley. Although industry took a similar approach with the salinity trading scheme by working through the NSW Minerals Council, this is a more hands-on approach where we collectively fund and manage equipment, models and computers, and use that data as a collective to manage the environment in this region," he said.

"This is an example of industry collectively deciding to address a pervasive problem and solving it in the true ACARP spirit. We went through the whole range from hypothesis to solving the problem, disseminating the answer and putting it into practice. It is rather unusual from that point of view."

Bruce was responsible for coordinating the establishment of the joint venture and monitoring the project outcomes.

Blast overpressure is an air pressure wave created by blasting coal or overburden and typically sounds like thunder. To minimise community disturbance, regulatory limits must be observed at private residences. At times, atmospheric conditions can enhance blast overpressure and cause unexpectedly high readings, sometimes resulting in limit breaches. Until recently, prediction of overpressure enhancement from atmospheric effects has been extremely difficult and quite inaccurate.

Terrock's Alan Richards teamed up with Holmes Air Sciences Atmospheric Modeller Nigel Holmes to investigate the problem. Alan said their work confirmed that meteorological conditions had a significant impact on blast overpressure.

"Atmospheric conditions can increase air blast levels by up to 20 decibels. To control this effect, we need to know more than the surface conditions; we need to know the temperature, wind speed and wind direction above ground, up to 1000 metres," he said.

Alan and Nigel worked together to deliver a desktop system that enables mine personnel to determine when unfavourable atmospheric conditions for blasting will occur. The ACARP/MM5 system comprises a mesoscale meteorological model, which has been used in conjunction with broad-scale forecast data from the Bureau of Meteorology and the American National Centre for Environmental Predictions. The model provides three-dimensional predictive atmospheric data suitable for use in the Hunter Valley for the next 24 hours.

A reality check on the forecast data from the ACARP/MM5 model is obtained from local observations that are provided by a sound detection and ranging system (ground to 1000 metres) and a radio acoustic sensing system (up to 600 metres above ground level) centrally located in the Hunter Valley. In addition, wind speed and direction data from ground-based sensors are also used.

MM5 was developed by the Pennsylvania State University and the National Centre for Atmospheric Research (NCAR) at Boulder, Colorado, USA. NCAR has recently released a model known as WRF, which is essentially a replacement for MM5. It will be the focus of future support and development by NCAR and so the ACARP system is being changed to operate with the WRF model. The ACARP/WRF model will provide detailed forecast data for use in the Hunter Valley for a period of up to three days.

"It took us about a year to set it up and test it, and we were then able to feed the data to Alan so he could put it into his atmospheric refraction model. He has developed a website that enables users to determine what the blast overpressure footprint might look like under the forecast conditions for any time in the upcoming day," Nigel said.

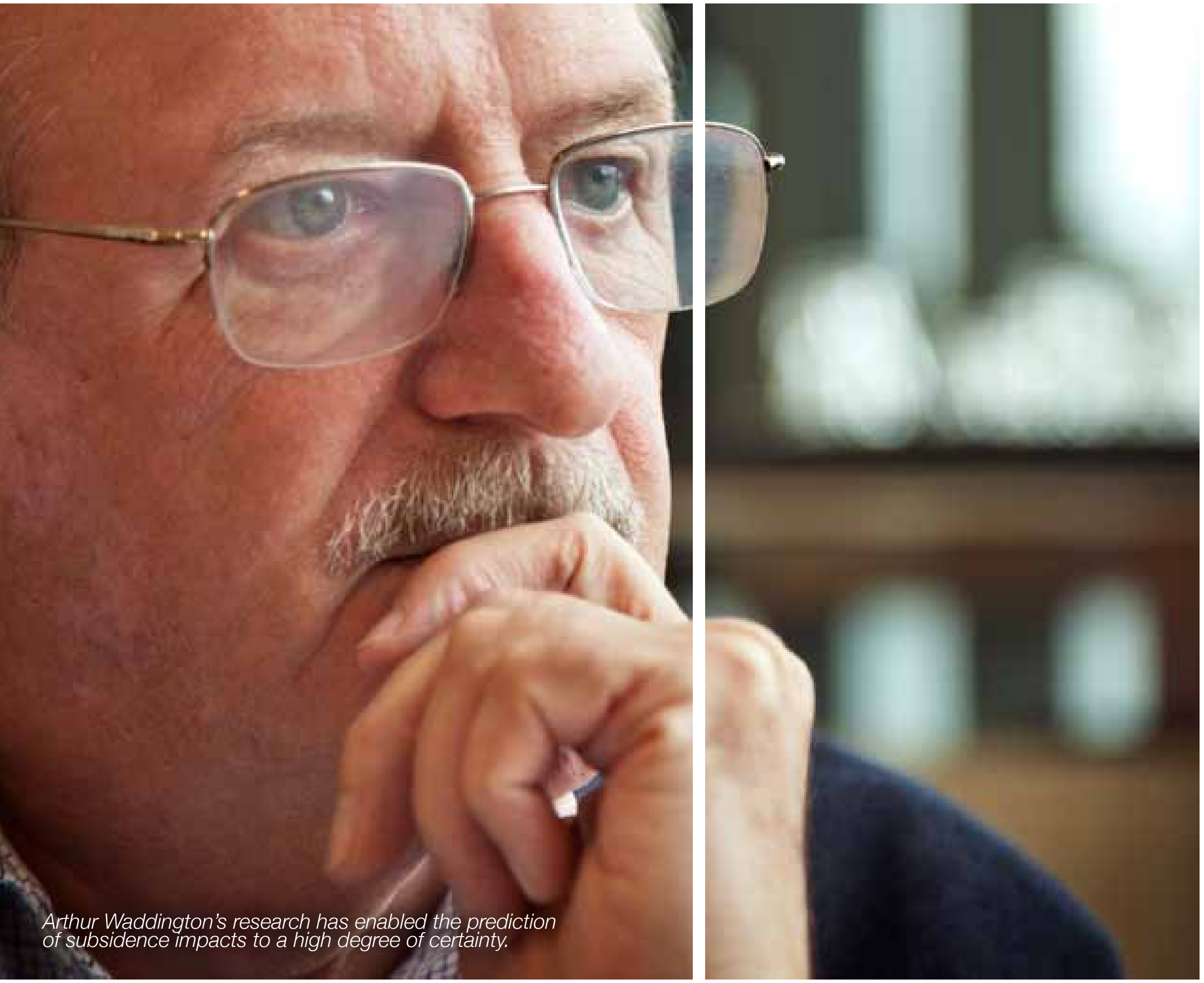
Bruce said the modelling gave the joint venture partners confidence that they could reliably predict atmospheric conditions right across the Hunter Valley. Since the monitoring facility was established there has not been a blast overpressure exceedence due to meteorological conditions that wasn't predicted by the model.

> "This is an example of industry collectively deciding to address a pervasive problem and solving it in the true ACARP spirit."
> - Bruce Foster

Nigel Holmes, Bruce Foster and Alan Richards at the meteorological monitoring facility.

USING SCIENCE TO ADDRESS MINE SUBSIDENCE IMPACTS

Being given approval to mine week-by-week, cut-through by cut-through makes managing an underground coal mine extremely challenging, but that was the situation facing Illawarra Coal at Tower Colliery in 2000 when Longwall 17 was approaching the twin bridges over the Nepean River at Douglas Park.



Arthur Waddington's research has enabled the prediction of subsidence impacts to a high degree of certainty.

Arthur Waddington and his team at Mine Subsidence Engineering Consultants (MSEC) undertook a series of ACARP projects that addressed mine subsidence impacts. A significant result of this work, undertaken over the past 15 years, has been the compilation of a comprehensive database of subsidence measurements in the Illawarra region.

Gary Brassington, Manager Approvals at Illawarra Coal and an ACARP monitor for many of these projects, said MSEC's research had put subsidence data in a format that the industry could now use. For today's mine planning processes this has enabled the prediction of subsidence impacts to a high degree of certainty.

"When mining occurs near specific surface features, we have greater confidence in our ability to predict and manage potential subsidence impacts. Approvals granted recognise our ability to manage predicted impacts, and the contingencies we have in place to manage situations if they go beyond predetermined levels," he said.

Mine subsidence measurement techniques have advanced dramatically over the past 15 years – from weekly surveys of pegs staked at 20-metre intervals to real-time monitoring with data constantly fed back to the monitors and inbuilt triggers to advise when mitigation measures are required.

Successful management of mine subsidence impacts on the built and natural environment is the result of a much better understanding of the process, the implementation of appropriate preventive measures, the introduction of sophisticated monitoring, the use of experts to design effective mitigation measures, and better relationships developed with stakeholders through open communication and the sharing of reliable data.

Getting all these elements right was critical to the success of Illawarra Coal's proposal to mine under the Hume Highway, a project that, not unexpectedly, initially faced opposition from key stakeholders when it was first mooted in 2006. Carrying more than 39,000 vehicles a day, this is one of Australia's most important road corridors.


Gary Brassington and Arthur Waddington at Marhnyes Waterhole, which has been rehabilitated following predicted subsidence effects from West Cliff Mine.

The potential for stress to develop in the sub-base pavement layer was identified as a major risk. This was resolved by the installation of a comprehensive monitoring network and 47 slots along the highway. The slots, around 500 millimetres deep and 90 millimetres wide, cover the whole pavement width and are filled with a layer of foam topped by a layer of asphalt.

Arthur Waddington said that fibre optic cables were being used for the real-time monitoring system, which recorded temperature and strain at 10-metre intervals along the affected length of each carriageway. It was the first time this type of monitoring had been used in this type of application and it was one of the largest optical fibre monitoring projects in the world.

“The measurements are fed back to us in our office. We can see when stresses are building up in the carriageway at a particular point. When they reach a certain trigger, additional slots are cut across the highway pavement so it is free to move and redistribute the stresses that are building up from mining,” he said.

In December 2011, this project won the Premier’s Public Sector Awards, infrastructure category. It was nominated by the RTA (now Roads and Maritime Services).

In 2009, Arthur, Don Kay and MSEC won an ACARP Research Excellence award for the prediction of mining-induced movements in building structures. In 2010, Illawarra Coal won the National Category for Construction and Engineering Projects (less than $100 million) in the Australian Institute of Project Management Awards for successfully mining beneath a section of the Upper Canal, an important part of the water supply for Sydney.

Other prestigious awards have been presented for the management of subsidence impacts on the Main Southern Railway at Tahmoor and major gas pipelines at West Cliff in New South Wales.

While significant progress has been made towards addressing the impacts of mine subsidence on infrastructure and the built environment, further research is being undertaken on addressing impacts for the natural environment.

TACKLING WATER ISSUES

RESEARCHERS HELP MINES SOLVE CRITICAL WATER ISSUES

Initial seed funding provided to two Queensland research centres has helped solve critical water issues facing the coal industry.

Through this funding Larelle Fabbro, CQU Group Leader Eco-toxicology in Industrial Waters has been able to undertake research into blue-green algae and Sue Vink, Centre for Water in the Minerals Industry Principal Research Fellow, to focus on the impacts of saline mine water discharge.

In addition, post-graduate research scholars have gained practical experience from a range of ACARP projects and leading practice methodologies have been transferred from the researchers onto mine sites.

"There has been a huge knowledge transfer in terms of processes used to treat algal blooms and systems of monitoring blooms. Any new research results make very rapid transfer between research or management bodies and industry," Larelle said.

"It's also enabled a lot of training of young people; many of those who have assisted me on ACARP projects are now managers in the industry."

Sue said these projects offered her students the opportunity to undertake fundamental research and to see the applied outcome of that work.

"We usually work very closely with site environmental officers and there's always knowledge transfer at that level. You end up in a partnership where researchers get to understand the company or site perspective and see the outcomes of their research put into practical use, resulting in genuine changes on how the sites operate," she said.

"It's been fantastic to be part of these projects. I get to work with really smart people who genuinely want the knowledge from the research to be able to improve their management practices. They also understand that research is research and they may not get the answer they want; but they're accepting of that."

Larelle Fabbro tests water quality at Norwich Park Mine.

ADDRESSING BLUE-GREEN ALGAL BLOOMS IN MINE WATERS

Although Larelle Fabbro started her professional life as a medical laboratory scientist, she turned her attention to blue-green algae after her younger son became ill from drinking water contaminated with algae.

"Much of the work I did as a medical scientist was concerned with liver damage. The most common toxin in the Fitzroy Catchment damages the liver, so it was via the connection between liver damage and algal toxins that I came to the area of blue-green algae research," she said.

"I was also interested as at the time my son was ill there was an algal bloom in the Rockhampton barrage on the Fitzroy River. I went down and took a sample and found that it contained evidence of a large bloom of one of the common potential toxin producers."

Central Queensland has optimum conditions for producing blue-green algae. Nutrient inputs to streams and large changes in temperature – very cold winters and very hot summers – alter the hydrodynamics of the water column, making conditions conducive to algal outbreaks.

Managing blue-green algae in mine waters is an issue facing many Bowen Basin operations. The coal industry realised it needed specialist expertise to help deal with this issue so it brought Larelle on board. Her early work centred on testing mine waters for algal toxins, assessing the validity of existing water treatment methodologies, isolating the factors triggering toxic algal blooms in mines thereby providing prior warning of their occurrence, and providing water treatment methodologies for the algal species present on site.

This initial work found that there was an increased frequency of algal blooms in the spring and summer. However, the often used treatments for killing the organisms do not necessarily reduce the toxicity. The most cost-effective and reliable method of reducing the human health risks associated with algal blooms is through water treatment using sand filtration, activated carbon and disinfection with chlorine. Activated carbon should be used in the water treatment process rather than applied directly to the dam.

Since that time, Larelle's research has covered a range of control techniques including aquaponics. Floating pontoons containing selective plants (such as tomatoes, silverbeet and basil) were installed at a major coal operation to reduce the macro and micro-nutrients that blue-green algae need to grow. This technique was found to be effective in addressing small-scale outbreaks, but water filtration remained the best method of managing large blooms.

Recent research has been directed at accurately determining which blue-green algae actually produce toxins. This is a key element in the reduction of human health risks and the basis for implementation of enhanced or targeted water treatment. The toxin producing genus *Limnothrix* and a number of other toxin-producing species were identified as a result of this research.

"Large culture collections were established in Adelaide and Rockhampton to facilitate detailed research on these species," Larelle said.

"Originally these species of blue-green algae were never thought to produce toxins, so if there was a bloom, additional water treatment protocols would not be implemented with the subsequent risk of toxin going through the water.

"We'd been trying for many years to work out another method for assessing toxicity. Now we were able to use a combination of modern genetics techniques and microscopy to identify which species could produce the toxin in mine water storages. Prior to this project, the only known toxin-producing blue-green algal species found on industrial sites in this region was *Cylindrospermopsis raciborskii*."

As a result of this program of work, guidebooks containing colour microscopic photographs of the toxin-producing algae have been published so that professionals in the water industry can identify particular algae and use the drinking water guidelines, which were published in December 2011, to determine the most effective mitigation measures.

Not only has this leading-edge research helped the coal industry better manage blue-green algal blooms, but it has provided expertise beyond mine boundaries into the broader central Queensland community and around the world.

Xstrata Coal Land and Rehabilitation Manager Bernie Kirsch was involved with this research from its inception and noted the importance of the work Larelle has undertaken for the coal industry.

"Larelle is a highly committed researcher who not only provided solutions to a critical issue locally, but has since been regularly invited to contribute globally through her engagement with the World Health Organisation," he said.

TACKLING WATER ISSUES

DETERMINING THE BEST TIME TO DISCHARGE SALINE MINE WATER

When is the best time to discharge saline mine water into Bowen Basin waterways – early or later in the wet season; as stream flow is increasing or decreasing?

No-one currently knows the answer with any certainty, but a three-year project being undertaken by the Centre for Water in the Minerals Industry is set to turn that situation around. Sue Vink and her team are developing new techniques to determine the sustainable salt load for the Isaac River system, quantifying the impact of saline discharge on aquatic ecosystem processes, and developing guidelines for flow and water quality conditions that will minimise environmental impacts of mine site discharge.

This worked was predicated by a series of 1:100-year floods in Queensland, making water management a critical issue for mine sites. Flood waters left many mines with the expensive problem of pumping water around a site rather than being able to release it.

Sue said the knowledge gained from this work would underpin an integrated approach to sustainable water quantity and water quality management by coal mines in the region.

"This research will provide vital data and modelling techniques for developing a more informed set of discharge criteria based on sound scientific understanding of the river system in which the mines operate, and the capacity of the system (both hydrologically and ecologically) to cope with saline discharge," she said.

The work is being conducted in the Isaac River Catchment and the researchers are surveying a range of ephemeral streams and seasonally flowing rivers. The project is combining modelling techniques with field measurements of water and salt fluxes and ecosystem processes. The field program is being complemented by laboratory experiments to test specific hypotheses developed from the field study. These experiments will verify and quantify the underlying mechanisms of action by salts on microbial metabolism in river sediments. The output of the work will be a report which provides analysis of water quality and discharge impacts under a range of hydrological conditions throughout the catchment.

Sue Vink checks progress on her laboratory experiments.

> "The knowledge gained from this work would underpin an integrated approach to sustainable water quantity and water quality management by coal mines in the region."

Sue Vink and Alex Henderson ... helping mines better manage the drought-flood cycle.

mechanisms of action by salts on microbial metabolism in river sediments. The output of the work will be a report that provides analysis of water quality and discharge impacts under a range of hydrological conditions throughout the catchment.

This project is part of a program of work on saline mine water issues that is being supported by the coal industry. Early research investigated the consequences of re-using water on mine sites on the salinity of mine water, the impact of saline discharge on fresh water ecosystems, and eco-toxicology work on the impacts of salinity and sulphate on macro-invertebrates. Current research is focusing on the development of a climate variability model to predict changes in the water and salt balance on site in association with Damian Barrett now with CSIRO.

“As a result of this work, you’ll get better predictive capability about how your site’s water management might be able to be changed to mitigate some of the risks around discharge. Being able to predict the impact of La Nina or El Nino cycles will help sites better manage the drought-flood cycle and avoid surprises,” Sue said.

“Another project we’re looking at is the energy trade-offs associated with managing mine water. Every water problem is an energy problem because if you want to move water you’ve got to expend energy to pump it, so we’re looking at the energy costs of managing water and salt balances on site.”

SCIENCE SOLVES RIVER DIVERSION DILEMMA

It took a geomorphologist characterising more than 100 kilometres of Bowen Basin river beds on foot to help break a five-year moratorium on river diversion approvals for coal mining leases.

With up to 30 per cent of river diversions on Queensland coal mines failing in the 1990s, it was no surprise that approvals for new diversions were not forthcoming. As a result, operators were unable to access some prime coal reserves.

By chance John Merritt, former ACARP Environment Committee member, met Alluvium Consulting Director Ross Hardie at an industry forum in Moranbah and realised that a team of geomorphologists from outside the mining industry had the scientific and waterway engineering expertise to understand why the diversions were failing and to develop design criteria to achieve stable river diversions.

Ross said prior to this research, industry did not have an adequate understanding of the way central Queensland rivers operated and there were no established criteria for analysing river diversion designs other than comparison with reaches upstream or downstream.

Ross and his team assessed seven river diversions that were at least 10 years old. He found that diversions that had failed due to erosion had stream power well outside the bounds of the natural streams of the region. Diversions that were filled with sediment had stream power much lower than the natural streams. Diversions that had remained stable had stream power equal to the natural streams in the region.

“Stream power is a mathematical computation of the capacity of flowing water to erode, scour and transport material,” Ross said.

“What this told us was that if you designed and built a diversion with the characteristics of the region’s natural rivers, you would be in the right ballpark.”

As part of the ACARP research project, fellow Alluvium Director Rohan Lucas characterised more than 40 of the region’s waterways from south of Moura up to Collinsville. Using a combination of geology, topography and basin-scale drainage network patterns, he identified two major reach types – high-capacity, deeply incised reaches that contain most flood events within their channels and low-capacity reaches with large flood plains that carry substantial sediment.

He also characterised a range of parameters including hydrology (how much water comes down out of the catchment into the streams), the velocity (how fast the water moves in the streams), the bed grade, channel width, shear stress and stream power. This resulted in setting upper and lower limits for a range of flood events such as 1:2 year, 1:50 year and 1:100 year events.

John Merritt said these parameters had been in use for about 10 years. They had been widely accepted by industry and had been used by the regulators to assess river diversion designs.

“The key to the success of this research was giving the regulator confidence that we could use science to quantify natural streams and that we could build diversions that behave just like those natural streams,” he said.

A decade on, Ross and Rohan are assessing the performance of river diversions that were constructed using the parameters they developed. So far Rohan has found a success rate of around 95 per cent. Getting vegetation established prior to significant flood events is important to achieving stability of the diversions. Many of the natural rivers in the Bowen Basin don’t

Peak Downs Mine successfully diverted Cherwell Creek. This series of photographs show how well the diversion has been maintained from initial work in 1999, 2007 and 2011. Photos courtesy of Rohan Lucas and Ross Hardie.

erode much due to the sediment supply and the well-established vegetation communities on the bed and the banks. The trees, grasses and shrubs help hold the streams together. As part of this latest project, Rohan and Ross are also developing closure criteria for river diversions on mine sites.

While working for Anglo American, John Merritt was the ACARP industry monitor for the initial three river-related projects, which he found to have direct benefits to Anglo.

"The advantage of being a monitor is that you can apply cutting-edge research and have the opportunity to solve your own company's issues on the way through. I was able to apply these parameters to our Cattle Creek and German Creek East diversions and they're still working well," he said.

> "The key to the success of this research was giving the regulator confidence that we could use science to quantify natural streams and that we could build diversions that behave just like those natural streams."

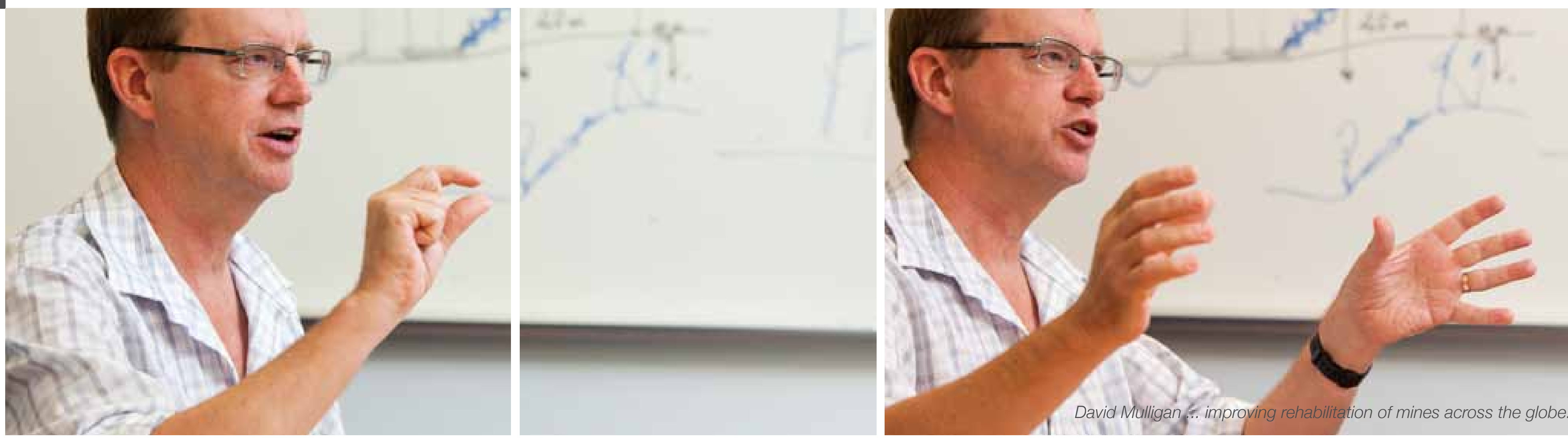
John Merritt at Isaac River.

MINE REHABILITATION

'WEEDS AND SEEDS' NO LONGER THE FOCUS OF MINE REHABILITATION RESEARCH

Over the past 20 years the Australian coal industry has invested many millions of dollars in a broad range of rehabilitation research. The focus of open cut mine rehabilitation has evolved from initial work on stabilising the landform through a process of understanding the relationship between the properties of the constructed soils and researching and planting of appropriate plant species, to exploring the development of native ecosystems and other sustainable end uses for mined land.

Bernie Kirsch and David Mulligan.



David Mulligan ... improving rehabilitation of mines across the globe.

Pioneering collaborative research that began in the early 1990s provided the science to address an issue confronting all Australian open cut mines – the surface stability of and erosion from reconstructed landforms.

The University of Queensland, the former Queensland Department of Primary Industries, the University of Newcastle and Australian Coal Industry Research Limited (ACIRL) joined forces to conduct laboratory, field and catchment-scale studies, which resulted in the development of criteria for predicting erosion rates on mine rehabilitation.

The natural dumping angle of a dragline is the angle of repose which results in steep slopes of material that is potentially very erodible. Rehabilitating the spoil is challenging due to the amount of earthworks required to reshape it, the uncovering of dispersive layers and the extra care required for the management of topsoil needed to establish a vegetative cover.

Centre for Mined Land Rehabilitation Director David Mulligan said the collaborative project included leading-edge computer modelling and predicting how different slope angles and lengths would behave under different rainfall scenarios.

“An erosion processing laboratory – essentially a tilting flume under a rainfall simulator – was built here at the university through the collaboration of world-renowned soil scientists Clive Bell and Bing So with ‘erosion guru’ Rob Loch who was with the Queensland Department of Primary Industries at the time. We were able to bring bulk material from the sites and use the simulator to ‘rain’ on the materials in different intensities on various slope angles and work out the characteristics that impacted erosion,” he said.

“One of the fundamental things in the erosion equation is the erosivity; once you have determined erosivity, then in theory you can predict the optimum slope angles and landform.”

Following the laboratory work, rainfall simulators were used in field and catchment trials at mines in the Bowen Basin to validate the data at scale. The modelling now allows prediction of erosion rates for various combinations of slope and spoil or soil type.

David said the principles, practices and outcomes developed from this work had been used to support the development of stable post-mining landforms in many other rehabilitation programs, including the non-coal sector and across operations nationally and globally.

“This was a very substantive project with significant funding and in addition to the results it produced a number of PhD and Masters’ students who have gone on to bigger and better things,” he said.

MINE REHABILITATION

SELECTING THE RIGHT SPECIES FOR REVEGETATING DIFFICULT SPOIL CONDITIONS

Selecting plant species to successfully revegetate post-mining landforms requires more than a cursory glance at the neighbouring flora. While locally adapted native species may thrive in natural landscapes, mining has changed the original landform, usually resulting in vastly different nutritional and hydrological conditions.

To address this, soil scientist Bevan Emmerton and botanist James Elsol conducted field examinations of plant communities and their associated soils in western and central Queensland. They identified around 60 native groundcover, shrub and tree species that either tolerate or exploit natural soil conditions that have similarities to difficult spoil conditions. These included Mitchell grass, spinifex, chenopods, yapunyah, blackwood and gidgee.

Bevan said central Queensland coal mine spoils were often difficult to rehabilitate by conventional means and that the selection of rehabilitation species historically had been largely driven by commercial availability and initial success.

“Current post-mining rehabilitation practice in central Queensland often involves replacement of a relatively thin, around 200-millimetre layer of topsoil over elevated and sloping spoil material which is sodic, saline and/or acidic, followed by seeding with naturalised or native grasses and a limited range of native tree and shrub species,” he said.

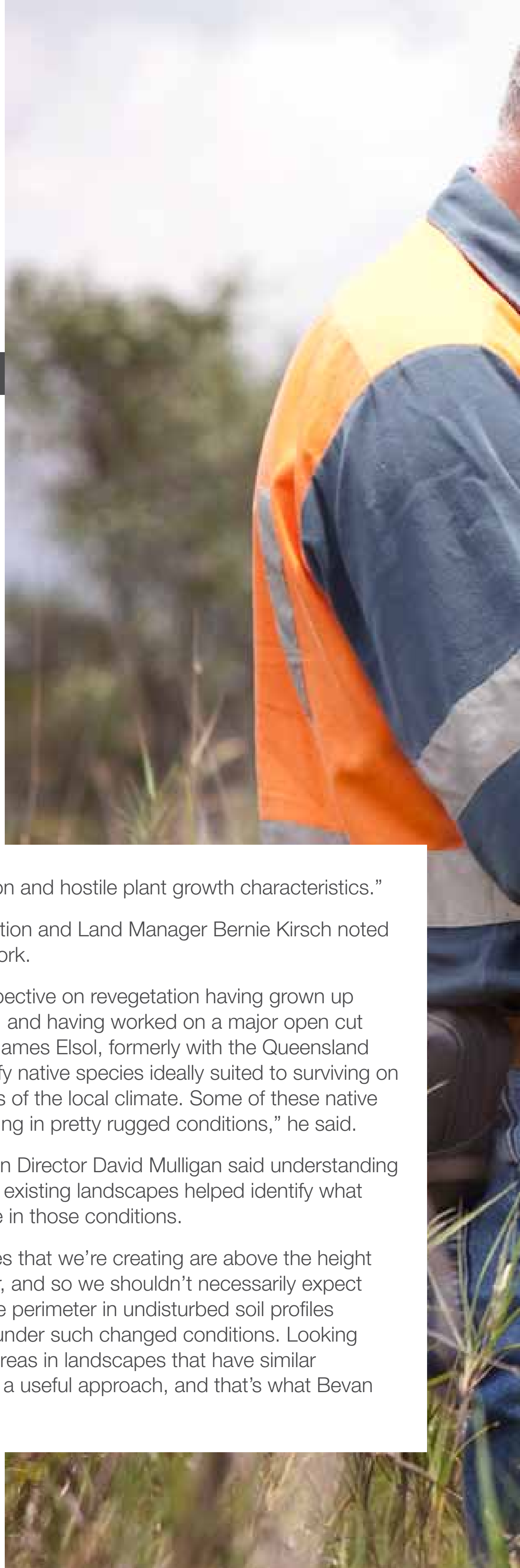
“While satisfactory initial cover of grasses and trees is sometimes achieved, plant cover often declines over time due to low infiltration rates of the recontoured sloping material; nutrient rundown of the replaced, mainly duplex soils; and sheet and rill erosion of the replaced soils over time, exposing areas of spoil with both poor rainfall infiltration and hostile plant growth characteristics.”

Xstrata Coal Queensland Rehabilitation and Land Manager Bernie Kirsch noted the importance of the pioneering work.

“Bevan brought the complete perspective on revegetation having grown up in the bush, been university trained, and having worked on a major open cut site for many years. Together with James Elsol, formerly with the Queensland Herbarium, they were able to identify native species ideally suited to surviving on challenging materials in the vagaries of the local climate. Some of these native trees and shrubs identified are thriving in pretty rugged conditions,” he said.

Centre for Mined Land Rehabilitation Director David Mulligan said understanding the impact mining had made to the existing landscapes helped identify what types of plant species might survive in those conditions.

“By their very nature, the landscapes that we’re creating are above the height of natural water tables and are drier, and so we shouldn’t necessarily expect species that are growing around the perimeter in undisturbed soil profiles on flat ground to be as successful under such changed conditions. Looking for additional species in semi-arid areas in landscapes that have similar characteristics to spoil piles can be a useful approach, and that’s what Bevan and James have done,” he said.



BHP Billiton Mitsubishi Alliance Manager Environment Regulation Peter Roe, Norwich Park vacation student Ronni Maciejowski and Norwich Park Graduate Environmental Advisor Leah Walker examine buffel grass on rehabilitated mined land.

MINE REHABILITATION

GRAZING THE SURFACE AFTER MINING

What is the most appropriate post-mining land use? That's an issue that mining companies have grappled with for several decades. Many operations in Queensland's Bowen Basin have aspirational goals of returning their leases to grazing land, but is that feasible or even welcome?

Centre for Mined Land Rehabilitation researcher Bob Maczkowiack has been exploring this issue. One of the major considerations of returning mined land to grazing is commercial attractiveness.

"Site attractiveness is really about it being worthwhile from a commercial perspective. This, in turn, will be driven by the number of cattle able to be supported on a parcel of land and the level of management input required to sustain those numbers on the land on which they graze. In addition, if the rehabilitated site is not contiguous with the grazier's current property, the number of stock that can be carried needs to be greater to offset the inefficiencies of managing cattle as a separate herd. At the very least the rehabilitated site needs to be stable and resilient enough to cope with the impost of grazing by hooved animals in a variable climate and potentially erodible substrates. The site also needs to have landform features that would enable permanent stock water supply," he said.

"The solution is for mining companies to give consideration to the site's ultimate use much earlier in the life of the mine; a firm commitment to landholders and regulators to definitely construct large, productive grazing paddocks rather than a 'wait and see how it turns out' approach.

"Graziers also have a good understanding of the land and despite the fact that their expertise has been overlooked for a long time, they could provide constructive input to this process.

"If companies aim to return land to grazing, they've got to look at things like slope angles, depth of topsoil and even the location of relinquished leases.

Returning mined land to grazing ... no simple task.

I would also recommend that senior levels of mine management regularly engage in one-on-one consultation with graziers to establish and maintain ongoing relationships."

In addition to the graziers of the region, Bob surveyed 140 people representing mining companies, regulators, grazing associations, local government and the indigenous community to determine expectations for post-mining land use. Grazing remains a key expectation, but bushland was also identified as an appropriate land use. Survey participants identified five key risks to successful post-mining land use – surface and sub-surface erosion, fire, weeds and feral animals. Bob is modelling the likelihood and likely consequences of each risk factor for each land use.

"We will be able to identify the key factors to which sites are sensitive. It is already evident that some of these factors – such as the architecture of the site – will be under the control of mining companies. If the companies are aware of these factors early on, they will be able to address them," he said.

The conditions on many of the mining leases granted in the Bowen Basin required the return of mined land to grazing use. Grazing trials undertaken on several mines in recent years have indicated that live weight gain for stock on rehabilitation pastures can match those from grazing non-mine pastures.

Bob has an extensive background in the agricultural industry and he has had a long association with buffel grass, an introduced species regarded by some as a hardy and productive cattle pasture species, and by others as an environmental weed.

"Mine managers need to maintain relationships with graziers" - Bob Maczkowiack.

ADDRESSING GREENHOUSE GAS EMISSIONS

MINERS HAVE A HEAD START IN GREENHOUSE CHALLENGE

The Australian coal industry identified greenhouse gas emissions as an emerging issue long before climate change became part of the global vocabulary.

The Mine Site Greenhouse Mitigation Committee was established in 1998 to bring an appropriate focus to this area and to address research issues associated with the liberation of greenhouse gases during coal production. A wide-ranging emission management and abatement scoping study, completed in March 1998, was used to set priorities for a series of more focused scoping studies and specific projects.

Committee Chairman and BHP Billiton Mitsubishi Alliance Manager Environment Regulation Peter Roe said the industry supported some early work around the assessment of overseas technologies.

"There were technologies that had been developed in the USA and Canada, not necessarily focused on mine emissions, but on things like dry cleaning centres and spray paint facilities where they needed to control a hydrocarbon component in their emissions," he said.

"One of these – thermal oxidation – was trialled at an operating underground mine in Australia to successfully abate ventilation air methane."

Other mitigation and utilisation measures that have been assessed include the rotary kiln, porous burner, biological controls, lean burn and catalytic turbines, and flaring.

The industry also funded research into the measurement of greenhouse gas emissions, including drilling techniques, lasers, flying drones across the top of open cuts and borehole gas analysis.

However, it became apparent in the lead-up to the introduction of the 'carbon tax' that the industry needed to have a much more rigorous means of measuring or estimating emissions from coal mines. In May 2009 the Fugitive Emissions Task Group, chaired by Xstrata Coal Underground Mining Manager Jim Sandford, was established to steer the development of guidelines for practical, cost-effective techniques to estimate and measure mine site fugitive emissions. Having completed its role, the task group was disbanded in March 2012.

Jim Sandford and Bob Korczynski at the pilot ventilation air methane abatement plant, Bulga Operations.

INDUSTRY FINDS A BETTER WAY TO MEASURE GREENHOUSE GAS EMISSIONS

The Australian coal industry has developed a rigorous method for estimating greenhouse gas emissions from open cut coal mines and the accompanying guidelines have been referenced by the federal government in the National Greenhouse and Energy Reporting (NGER) Act.

The open cut guidelines and the technical discussion document were published in December 2011 and the underground guidelines were completed in 2012. This work has been driven by the Fugitive Emissions Task Group under the chairmanship of Xstrata Coal Underground Mining Manager Jim Sandford. Jim said that this task group functioned somewhat differently from other ACARP task groups in that it required far more external consultation, in particular with Commonwealth bureaucrats, lawyers and auditors.

“People had to have confidence in our numbers and the process had to withstand a legal and audit review. We used science and research as the basis of our work and the protocols enabled others to verify that the outcomes are acceptable to within a prescribed tolerance,” he said.

“One of the key issues was around low gas measurement. The makeup of emissions from low-gas mines tends to be carbon dioxide with a little nitrogen rather than methane, which has a greenhouse warming potential of 21 times carbon dioxide. This has huge implications for really low-gas mines in Western Australia, southern Queensland and western New South Wales because previous NGER reporting assumed 100 per cent methane.

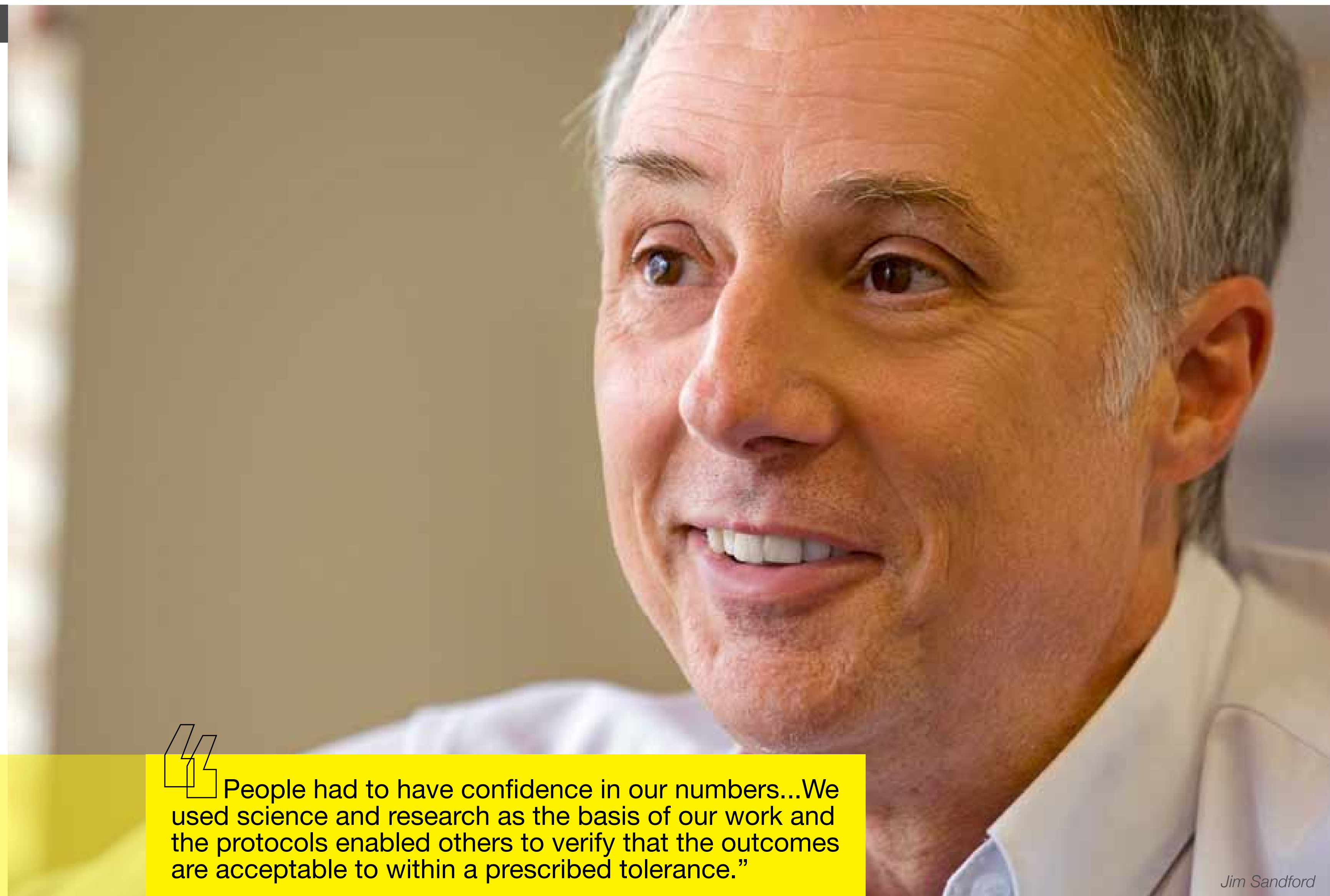
“The first thing we learned was to acknowledge the difference between custom and practice. We spent a lot of time challenging the industry status quo with fundamental science because what people had always accepted as being right just wasn’t precise enough, particularly for low gas measurements.

“We also had to learn how to report uncertainty and to understand the importance of having sufficient data. Unless you’ve got a really large data set and you can look at the population distribution, you can’t see the trends. The open cut guidelines now have a step-by-step process that shows how to test for data sufficiency and provides a simplified uncertainty calculation.”

The guidelines are based on a CSIRO methodology that uses gas analysis from boreholes. Gas content, gas composition and the thickness and position of coal seams and carbonaceous layers are used to calculate the emission factor in terms of volume of gas per tonne of coal produced (m^3/t) or per unit area of ground surface (m^3/m^2).

Some of the input data, such as the density and thickness of layers, is readily available from routine geophysical logging of boreholes drilled for exploration purposes. However, gas content and composition data are not routinely measured in open cut mining so it may be necessary to undertake additional drilling and sampling to accurately determine the distribution of these properties.

CSIRO presented this methodology in the form of a practical procedure summarised in a flowchart and demonstrated through examples from two mine sites – one in the Bowen Basin and the other in the Hunter Valley. The gas analysis for these mines was undertaken by two commercial laboratories.



"People had to have confidence in our numbers...We used science and research as the basis of our work and the protocols enabled others to verify that the outcomes are acceptable to within a prescribed tolerance."

Jim Sandford

ADDRESSING GREENHOUSE GAS EMISSIONS

SECURING THE FUTURE OF COAL THROUGH EMISSIONS REDUCTIONS

How do we emphasise the importance of coal to society and our everyday lives in a world concerned about the impacts of climate change and coal's contribution to it?

This question was at the forefront of David Cain's mind when he participated in an ABC 'Sunday Conference' television program back in 1988, with a studio audience that was overwhelmingly anti-coal. At that time David was a member of the ACARP Research Committee and was Chairman of its Coal Utilisation Committee.

"When the show went to air, creative editing encouraged viewers to believe we were on the brink of an imminent climate disaster, with coal the main culprit. Fortunately that disaster could be averted, as one child suggested on cue, by each of us planting a tree. That was when I really got to understand how deep the resistance to coal was … we all had a lot to learn," he said.

"In the early 1990s the coal and electricity generation industries were focused on near-term operational priorities and I became aware, with some help from my boss, just how big an issue was coming over the horizon in the form of global warming."

And how right he was. Coal producers and electricity generators faced increasing pressure from the global community over greenhouse gas emissions associated with coal-fired electricity generation. At the same time, rapidly growing energy demand meant that fossil fuels, including coal, would continue to meet the bulk of the world's energy needs for the foreseeable future.

As a result of his experience with the CRC for Black Coal Utilisation, David understood the advantages of collaborating to explore technologies around low emission coal use. When the CRC for Coal in Sustainable Development

David Cain ... advantages of collaborating on low emission coal use.

(CCSD) was being established, David believed it should be supported by ACARP.

"What we set out to do with the CCSD was a warts-and-all, no-holds-barred assessment of what coal's role was in energy supply. Everything we found was published – both the good and the bad," he said.

Jim Craigen, former ACARP Research Coordinator, said David was instrumental in getting ACARP to invest in cooperative research centres, which it had never done before.

"There was a general consensus that the program invested in people doing the research rather than institutions, but David presented a convincing argument and was able to shift that mindset. Almost single-handedly he also persuaded us that CCSD was worth getting involved in while former ACA Executive Director Mark O'Neill was instrumental in getting us into the CO2CRC," he said.

These centres were conducting major research and development programs into post-combustion capture, oxy-fuel, integrated gasification combined cycle and geological storage technologies at pilot and small demonstration scale. ACARP made a strategic decision to allocate $2 million a year to the CCSD, CO2CRC and the Centre for Low Emission Technology (cLET) and to provide them with diverse technical expertise.

Xstrata Coal Group Manager Coal Technology Barry Isherwood said a new committee – Low Emission Coal Use (LECU) – was established in May 2005 to coordinate ACARP's involvement in the three centres and he joined the committee.

"LECU was established because there was no existing committee that addressed the downstream issues of greenhouse gas emissions such as product stewardship and utilisation. The Greenhouse Committee addresses emissions during coal production rather than utilisation and, while the Technical Market Support Committee focuses on utilisation of coal, it's not really about greenhouse," he said.

"The committee funded a series of smaller research projects, including a feasibility study for oxy-fuel technology, which was a precursor to the Australian Coal Association Low Emissions Technologies (ACALET) Limited funded oxy-fuel demonstration project at Callide A Power Station; and a project to improve power station efficiency by optimising fuel distribution to the burner banks at coal-fired power stations.

"When it became clear that the CRCs and cLET would be discontinued, we funded oxy-fuel and coal gasification projects to retain lines of investigation and researcher capability while a new organisation – Australian National Low Emission Coal Research and Development (ANLEC R&D) – was established."

ACARP is focused on providing seed funding for research and development projects; however, low emission coal use technologies require significant funds to carry out demonstration projects. ACALET was established in December 2006 to facilitate this work with funding secured by a voluntary 20 cents per tonne levy from participating coal producers. LECU ceased operation in December 2008 having fulfilled its mandate.

David said the coal industry's understanding of operating in a carbon constrained world had grown dramatically since his appearance on the ABC.

"I think by the time I retired in 2008 the industry had gone from a position largely of ignorance to understanding what the issues were, to knowing what the potential solutions were and knowing what had to be done if those solutions were to be implemented. The industry was no longer complacent. It also went from reasonable optimism to a growing realisation that any solution to reducing greenhouse gas emissions from coal would be

"What we set out to do with the CCSD was a warts-and-all, no-holds-barred assessment of what coal's role was in energy supply. Everything we found was published – both the good and the bad."
- David Cain

5 DEVELOPING PEOPLE

SCHOLARSHIPS FOSTER DEVELOPMENT OF TECHNICAL EXPERTISE

ACARP is fostering the ongoing development of technical expertise across the coal industry through its Postgraduate Scholarship for coal industry employees.

Aunty Sandra Morgan, Elder of the Cherbourg Community, with Indigenous Relations Advisor Darren Schmidt.

University of Melbourne researcher Kerry Mudge greets Uncle Micky Bond, Elder of the Cherbourg Community.

The scholarships are awarded to professionals who are working in the coal industry who wish to complete a PhD or Master's degree by research. The work must be completed full-time and the topic aligned with the coal industry's research priorities. Scholars receive an annual payment of $100,000 tax free for the term of their study, up to three years.

"The program was initiated for two reasons: firstly, to advance knowledge and understanding about coal production and, secondly, to address an industry concern over dwindling numbers of strong technical personnel available," said Scholarship Coordinator Jim Sandford.

Recipients have found that the scholarships enabled them to carry out detailed investigations into significant issues of concern to the industry and to focus on the research without competing work demands.

"This scholarship is an amazing opportunity. I will never have another opportunity like this in my life to pursue my interests to this level of freedom without resource constraints," said scholarship recipient Kerry Mudge.

"I have been able to identify the problem, design the project, come up with a research question, find the case studies, conduct field work and then spend the next year writing about something that fascinates me."

Dennis Black said without this scholarship it would have been unlikely that he would have continued with the PhD.

"Given the demands of work – I don't think I would have had the time to do it properly and be successful," he said.

Russell Packham said the ACARP scholarship and the outcomes of his research enabled him to move to a technical role.

"The ACARP scholarship allowed me to focus on the research and develop a comprehensive understanding of how gases behave in coal seams. It has been a wonderful opportunity," he said.

RELATIONSHIPS AT THE HEART OF SUCCESSFUL NATIVE TITLE AGREEMENTS

There is no ‘silver bullet’ for negotiating and implementing successful native title agreements. They’re all about establishing strong, respectful relationships between the parties over time rather than purely focusing on the often ambiguous terms of the agreement.

This is one of the preliminary findings from research being undertaken by University of Melbourne PhD scholar Kerry Mudge. Kerry is exploring the implementation of native title agreements between indigenous groups and coal mining companies within the Australian coal industry. As part of this work, he is analysing the social and institutional processes through which implementation occurs; features of agreements; and implementation strategies that motivate, inform and empower people to achieve success. The aim of his research is to provide a social commentary on these relationships rather than developing a standard operating framework for negotiating and implementing successful native title agreements.

Native title is the legal recognition of the rights indigenous people have to land and water through their traditional laws and culture. Where indigenous groups can show they retain native title rights over land that is subject to a mining lease, they have the right to negotiate with mining companies regarding the loss of those native title rights. Often the agreements include other socio-economic provisions relating to employment, education and business development programs.

Kerry said the implementation process was challenging because the terms of the 20-year agreements were negotiated over a limited period and often did not take a long-term, strategic approach to implementation.

“These agreements are negotiated a year before the mine starts and they are often not reviewed throughout the life of the mining project. The agreements often address very complex issues from the destruction of indigenous land, culture and rights to overcoming employment barriers, developing small enterprise and the governance of substantial trusts. How can you expect a piece of paper that took six months to negotiate to effectively address these complex and dynamic issues over a 20-year period?” he said.

“My hypothesis is that implementation requires an ongoing and dynamic relationship and that this relationship is maintained by the people within the implementation process and their ongoing interactions with each other. Therefore it is important to analyse these relationships and the people within them in order to understand how successful implementation can be achieved.”

Kerry has been fortunate to secure supervision from two pre-eminent academics – Professor Marcia Langton, University of Melbourne, an indigenous leader, academic and advocate in indigenous land rights, legal reform, native title and agreement making; and Professor Ciaran O’Faircheallaigh, Griffith University, a world leading academic in the interactions of large resource corporations with governments and indigenous communities. Kerry expects to submit his thesis at the end of 2012.

Kerry Mudge

Dennis Black at the University of Wollongong laboratory.

Unanswered questions to a perplexing work issue was the impetus behind Dennis Black's decision to undertake a PhD research project.

As BHP Billiton Illawarra Coal Manager Gas and Ventilation, Dennis was faced with inconsistent coal seam gas pre-drainage performance from mines operating in the Bulli Seam, which had the potential to cause significant production delays and loss of coal reserves.

He spoke to experts at the University of Wollongong and elsewhere, and initiated a small work project, but the questions weren't answered to his satisfaction.

"It is a very complex issue with variable coal properties and geological conditions within the coal seam that prevent the gas from draining freely. I wanted to know why gas, in certain areas, under certain conditions, wouldn't drain freely, yet would drain freely from other areas. That was the impetus for undertaking further research and investigation, which ultimately led to my enrolment in the PhD program," he said.

"As the mines in the Illawarra and elsewhere get deeper and encounter similar gas issues that result in increased cost and production delays, there is a risk of sterilising potentially recoverable coal resources. Understanding what is going on and identifying key conditions that contribute to poor gas drainage not only has relevance in the short term, but the long term as well."

Dennis analysed hundreds of coal samples initially from West Cliff and other Bulli Seam operations, and then expanded the data set to include samples from the Hunter Valley and Bowen Basin. He reviewed geological reports and other pertinent information to compile a comprehensive database. As a result of his analysis, he confirmed that draining gas from under-saturated coal seams requires far greater time than from a similar saturated coal seam.

"In addition to identifying the significant factors that impact coal seam gas drainage and methods to improve gas drainage performance, I've also identified a specific formula based on the trends from the data set that I can use to estimate the gas content and plan for gas drainage," he said.

Dennis completed his PhD at the University of Wollongong under the supervision of Professor Naj Aziz. Since completing his studies, he has established his own company – Pacific Mining and Gas Management (Pacific MGM) – and consults around the country on gas drainage reviews, gas drainage improvements, reservoir analysis and gas modelling.

Russell Packham

A 'chance glance' at an article on a coal seam methane technology trial in the USA set Russell Packham on the path to identifying an effective means of enhanced gas drainage for underground coal mines.

The article described how nitrogen was being injected into the coal seam at high pressure to flush out methane. The rate at which methane is released from the coal seam through the cleats is determined by the amount of pressure the methane is under. By continually flushing the cleats with nitrogen, the methane is forced out of the coal at a faster rate.

With all the equipment and facilities already in place, the Oaky North Mine in Central Queensland was a logical site for Russell's field trial.

"As well as having facilities for a continuous supply of nitrogen at high pressure, Oaky North also had the facilities to monitor well pressure and gas flow, as well as gas chromatographs for monitoring samples from the production wells. We were able to analyse the composition of the gas as it came out of the production holes to see how much nitrogen was getting through," Russell said.

"The trial used three surface-to-inseam, medium-radius wells. We injected nitrogen into the central well, which flushed methane out to the peripheral wells. I analysed the data and constructed a computer simulation of the reservoir, which replicated the results, including the daily flow rates, reservoir pressure and gas composition achieved in the trial. By developing the reservoir model – which was a complex, time-consuming process – I was able to predict what would happen under different injection scenarios.

"This work has demonstrated that by putting methane under pressure you can accelerate the gas drainage process."

Having this methodology in the gas drainage toolkit enables mine operators to reduce the time taken to drain the gas reservoir ahead of mining when scheduling or mine layouts change due to unforeseen circumstances.

Russell is completing his PhD through the University of New South Wales under the supervision of Professor Yildary Cinar and Roy Moreby. With all the research completed and peer-reviewed papers published, he is in the throes of finalising his thesis.

Russell is currently Technical Manager Gas at Anglo American in Brisbane.

RESEARCH EXPERIENCE PROVIDES USEFUL INSIGHTS

Originally a consulting engineer in integrated water management, Claire Cote joined the research community in 2005 when she accepted a position with the Centre for Water in the Minerals Industry to undertake an ACARP research project on water use – efficiency measures and reducing consumption followed by a second project addressing mine water management.

RESEARCHERS BRING FRESH IDEAS AND NEW APPROACHES TO PROBLEM SOLVING

Fresh ideas, innovative techniques and new approaches to solving problems are some of the benefits the coal industry is reaping from researchers as they take up senior technical roles within mining companies. This move is contributing to the ongoing development of technical expertise across the industry and is a consequence of the successful relationships developed through the completion of ACARP projects.

Anglo American Environmental Specialist Claire Cote was introduced to coal industry research through her previous role with the Centre for Water in the Minerals Industry. BHP Billiton Mitsubishi Alliance Principal Technology Andrew Denman was a Senior Research Engineer with the University of Queensland working on the shovel load assist project (SLAP) before taking up his current role. Both former researchers are enjoying the challenges of their industry roles.

"Initially we worked with seven mines to define leading practice water management. We increased the number of mines to 25 and moved out of the Bowen Basin into the Hunter Valley which gave us a bigger data set," she said.

"We were the first researchers to give a clear, more integrated view of what mine water management was, the key risks and how to mitigate those risks.

"A lot of my initial work with Anglo American has been to apply the outcomes of these research projects across our sites. When I am asked to provide water targets or key performance indicators, I tend to go back to that data set:
'this is what leading practice is, this is the industry average, this is where we are … how do we compare?'"

In her current role, Claire works with the Regional Environment Manager and provides technical support to the mine sites. She is also a member of the ACARP Environment Task Group and monitors three or four projects a year.

"As a model for providing industry-focused research, ACARP is really successful. It is focused on developing practical research that can be applied at the mines. The monitors' meetings are always productive because everyone is keen for the projects to be successful; and it's very dynamic. Everyone is motivated to make a difference and no-one is inward looking," she said.

Claire said researchers who were considering moving into industry roles needed to be able to work at a much faster pace, have strong time management skills, organisational and management expertise, and a willingness to pitch in to do whatever needed to be done.

Claire Cote … enjoying new challenges in the coal industry.

TAKING RESEARCH FROM THE LAB TO THE COAL FACE

When Andrew Denman came across the advertisement for BHP Billiton Mitsubishi Alliance Principal Technology, he found the opportunity to move into a more strategic role very appealing.

“I was looking for a different challenge and this job seemed right for me. It was also nice to be in a position to take some of the technologies I was familiar with and put them on BHP Billiton’s horizon and actually see them come to fruition,” he said.

“My job right now is to assist in the development of a technology strategy that simplifies, systemises and standardises the business activity. There’s a long-term strategy where we need to apply mature technologies, but we also need to think about what’s coming in the future and how we can best prepare the business to take those technologies.

“It’s not a research position, it’s more about how we leverage off my experience in research and understanding of technologies – what will work and what won’t work – and use that to develop strategies to get the best value for BMA and BHP Billiton overall.

“We’re considering the whole value chain – from mine planning to dispatch, coal preparation, rail and the port. Ultimately it’s only what gets on the ship that earns BMA any money. It doesn’t matter how well we dig it out of the ground if we don’t get it onto the ships.”

Andrew said key skills that would assist researchers to transfer into the mining industry included good interpersonal skills, an ability to think outside the box, be outcome focused, and have a broad understanding of the mining process.

“My involvement with the shovel load assist project (SLAP) played a very big role in being able to take the step from researcher to industry employee. I think companies like candidates who have done some research and critical thinking on mining problems, have had exposure to real mining situations and are able to take that perspective into the industry,” he said.

“One of the benefits of being a researcher on ACARP projects is that it gives you exposure to other companies and through meetings and working with industry monitors you get to know the key people in your field.”

Andrew Denman at Bracalba Quarry, where the shovel loading assist project is being conducted.

6 CREATING COMPANIES

FROM RESEARCH PROJECTS TO NEW BUSINESS ENTERPRISES

New businesses continue to develop following successful research projects and thanks to seed funding from ACARP, a broad spectrum of innovative ideas has evolved from research projects into commercial enterprises.

The commercialisation of The University of Queensland's technology – the Slope Stability Radar (SSR) – led to the establishment of the company GroundProbe. Today GroundProbe employs 180 people in 20 countries around the world and sells the SSR into a wide range of open cut mining companies.

The development of technology by CRCMining to measure brainwaves in a mobile environment as a means of combating fatigue among the drivers of large open cut mining equipment has resulted in the creation of spin-off company, EdanSafe.

Smart thinking leads to smart cap to keep operators on their toes.

SMARTCAP – A BRAINWAVE FOR MEASURING OPERATOR FATIGUE

Using brainwaves to measure operator fatigue was an “off-beat” idea dreamt up by Daniel Bongers one weekend. The result of these musings is the commercial product SmartCap, which is being sold through CRCMining spin-off company EdanSafe into mining operations in Australia, North America, South America and Africa.

SmartCap is based on electroencephalography (EEG) technology which uses small electrical signals on the scalp to measure the various stages of fatigue from hyper-alert to clinically asleep. It communicates the fatigue results to an in-cab display in real time. Normally used in a clinical environment, Daniel was challenged with adapting the technology to a mobile environment in a package which would be non-intrusive to the user. Fitting the monitoring device into a baseball cap seemed a logical approach due to proximity to the brain.

“One of the challenges of fitting this device into a cap was the need for a flexible circuit board that was robust because the delicate electronics are easily damaged. We also needed to keep the electronics as close as possible to the scalp without being visible,” Daniel said.

The prototype was tested during two-week long field trials at Queensland’s Callide and Lake Lindsay mines with 53 operators participating on day and night shifts. Researchers collected around 800 hours of fatigue data.

“The feedback from operators was surprisingly positive. The biggest concern we had with asking them to wear a brainwave reading device that was monitored by management was pushback due to concerns about ‘Big Brother’ but we didn’t really experience that,” Daniel said.

“Forty-six operators went so far as to say that these sorts of things should be compulsory. Their concern was almost never about themselves, but about the other people on the site.

“Through these trials we got the information we needed about what would be required of the SmartCap if it was to go commercial in terms of the form, the fit, comfort and those sorts of things.”

Commercialisation of SmartCap has been strongly supported by Anglo American, which is rolling the technology out across all its Australian sites. Anglo American’s Head of Resource Development and Operational Excellence for the Metallurgical Coal business, Nick Barlow, has also joined the EdanSafe Board.

Daniel Bongers demonstrates the use of SmartCap.

“Forty-six operators went so far as to say that these sorts of things should be compulsory. Their concern was almost never about themselves, but about the other people on the site.”

Adaption of surveillance radar from defence to mining applications has delivered proven technology for continuously measuring the stability of open cut mine walls in real time.

Initially focused on Australian mining operations, GroundProbe's Slope Stability Radar (SSR) is now used in coal and metalliferous mines around the world to detect slope movements in rock formations to less than one millimetre.

Mutiple alarms can be set over a number of areas to warn of accelerated slope movements well before a mine wall collapses. Personal alert devices vibrate, beep, flash and display an SMS text message if slope stability parameters are breached.

David Noon with the Slope Stability Radar.

The original proof-of-concept prototype was developed as part of an ACARP project and was trialled at Drayton, Moura (Dawson) and Callide mines in Queensland.

GroundProbe Chief Commercial Officer David Noon said the research team detected its first low-wall failure at Callide.

"The radar was on top of the highwall scanning the low-wall when the low-wall failed. We collected data on the movement right up until the failure and could show that there was quite a lot of warning time before the wall collapsed – so that was a huge success," he said.

"We then completed a second ACARP project to make the prototype more usable and to get a better understanding of how walls move. We took our original system and put it onto a trailer, and added a camera and a generator so it would be self-powered. We put on a communications link so the data could be sent back to the control room to provide mines with data access and so they could control the system. We also built software to raise alarms based on user-defined thresholds."

The second generation system was trialled at Tarong and Callide mines in Queensland and Hunter Valley Operations in New South Wales. In 2002, The University of Queensland, Cooperative Research Centre for Sensor Signal and Information Processing and the SSR inventors joined forces to establish the company GroundProbe and commercialise the technology.

David said the biggest advantage of undertaking an ACARP project was the access it gave researchers to key industry professionals, such as Alan Davies (former BMA) and Wes Nichols (former Anglo American) and to operating mines so the technology could be rigorously tested in the field.

"We had excellent industry monitors who were very enthusiastic about this project and believed in it. They pushed us really hard and were very encouraging. They were really smart, understood rock mechanics and their advice was extremely valuable," he said.

In 2000 David, Dennis Longstaff, Bryan Reeves and Glen Stickley won an ACARP Research Excellence Award for the Slope Stability Radar. In 2008 David was presented with a Clunies Ross Award for this work. These prestigious awards are presented annually for the application of science and technology for the economic, social or environmental benefit of Australia.

A chance discussion with a bathhouse cleaner at Kianga mine in Central Queensland sparked Warren Seib's enduring fascination with highwall mining, a fascination that eventually led to a doctoral thesis on the subject.

"I could see there was an application for highwall mining in Australia as some of the open cut mines had reached their depth limitations, so I started doing a lot of personal research on the topic," he said.

"When I was Technical Services Manager at Callide I contacted a highwall mining contractor to do a very controlled auger trial. As a result of that trial highwall mining began to become a commercial option in Australia and a whole set of industrial relations positions developed around that.

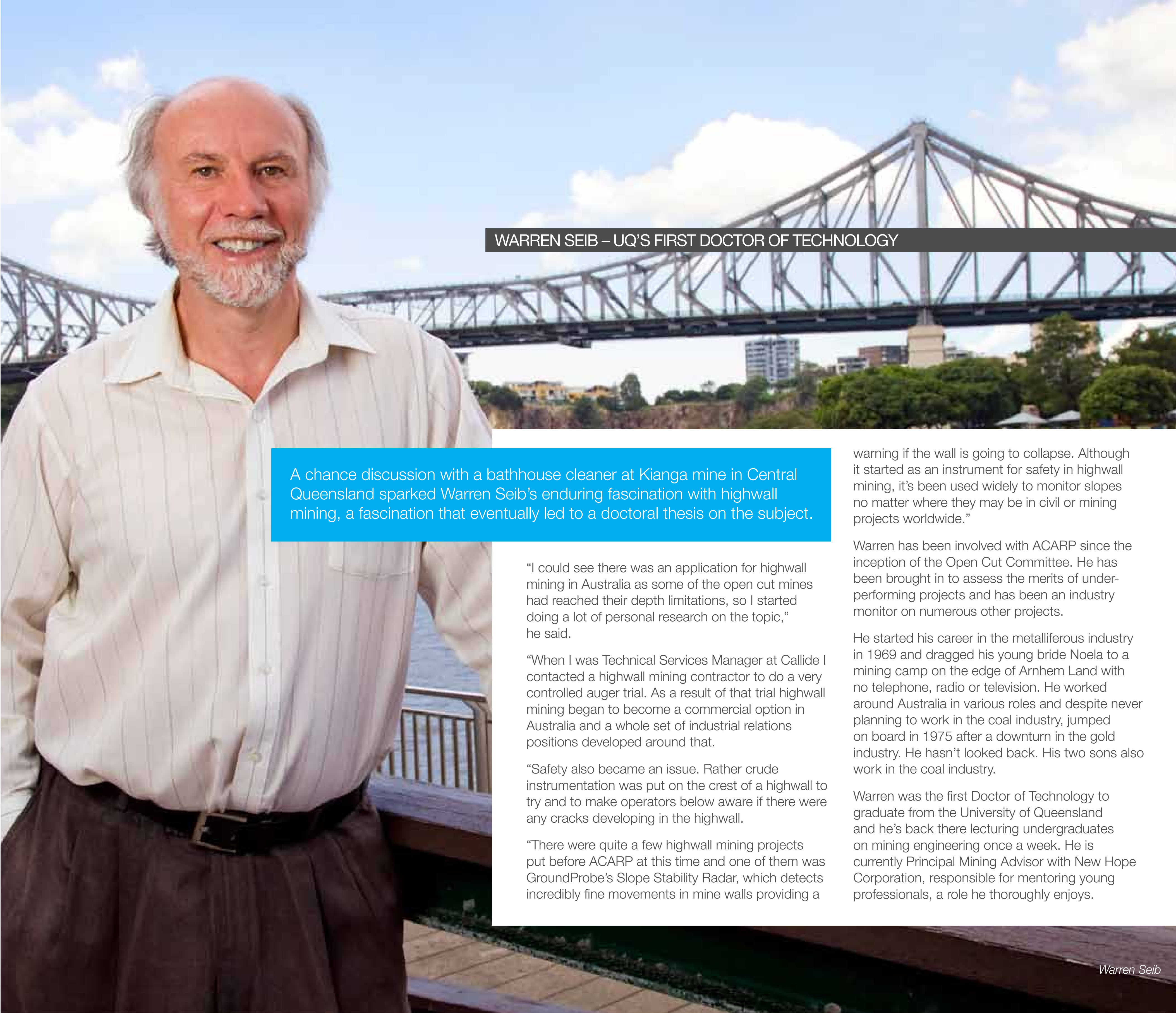
"Safety also became an issue. Rather crude instrumentation was put on the crest of a highwall to try and to make operators below aware if there were any cracks developing in the highwall.

"There were quite a few highwall mining projects put before ACARP at this time and one of them was GroundProbe's Slope Stability Radar, which detects incredibly fine movements in mine walls providing a warning if the wall is going to collapse. Although it started as an instrument for safety in highwall mining, it's been used widely to monitor slopes no matter where they may be in civil or mining projects worldwide."

Warren has been involved with ACARP since the inception of the Open Cut Committee. He has been brought in to assess the merits of under-performing projects and has been an industry monitor on numerous other projects.

He started his career in the metalliferous industry in 1969 and dragged his young bride Noela to a mining camp on the edge of Arnhem Land with no telephone, radio or television. He worked around Australia in various roles and despite never planning to work in the coal industry, jumped on board in 1975 after a downturn in the gold industry. He hasn't looked back. His two sons also work in the coal industry.

Warren was the first Doctor of Technology to graduate from the University of Queensland and he's back there lecturing undergraduates on mining engineering once a week. He is currently Principal Mining Advisor with New Hope Corporation, responsible for mentoring young professionals, a role he thoroughly enjoys.



Warren Seib

7 DEVELOPING PRODUCTS

ADAPTATION OF AMERICAN MILITARY TECHNOLOGY BOOSTS PRODUCTION AND IMPROVES SAFETY

Innovative use of American military technology has made Australian underground mines safer and more efficient.

Peter Henderson with the new longwall face at the Bulga Underground Operations.

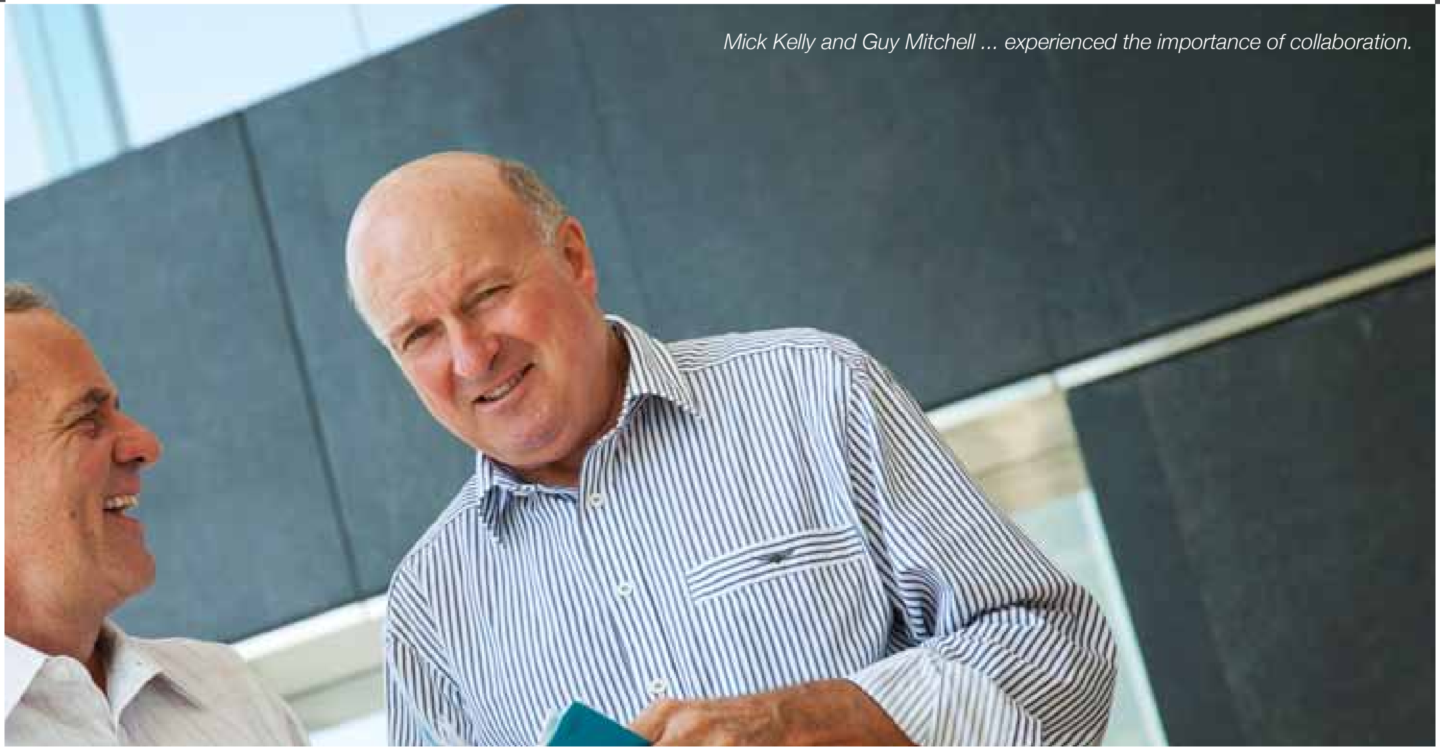
The drive and determination of a broad cross-section of researchers and mining professionals overcame significant technological challenges, the harsh underground mining environment and initial scepticism to deliver the world's first automated longwall face that accurately measures shearer position in 3D.

Not only has this advanced technology enhanced employee health and safety, but it has improved production by five per cent, lowered operating costs and improved return on capital.

A key to this breakthrough was CSIRO Exploration and Mining's adaption of the American military's inertial navigation system from missile and army tank use to installation on a longwall shearer underground. This innovative and complex solution required permission from the American Government to import the technology into Australia. It then required development of external software to process data collected from the system, a wireless Ethernet to act as a data link between the fixed longwall structure and the shearer, a method of backing up power to the inertial navigation system, and myriad other initiatives. To protect the components from vibration, temperature and other impacts, CSIRO housed the inertial navigation system and ancillary equipment in a heavy-duty, stainless steel casing.

"The beauty of this system is that you can bury the inertial navigation unit deep inside the shearer and it's pretty much invulnerable. I think that's the fundamental reason why it's been accepted – because people have realised that they just can't break it," said Automation Project Leader David Hainsworth.

Longwall automation was identified by ACARP's Underground Committee as an initiative that warranted a significant investment over several years, and allocated $6.7 million to this critical five-year, two-stage 'landmark' project. In 2001, stage one was awarded to CSIRO and CRCMining. CSIRO led the



Mick Kelly and Guy Mitchell ... experienced the importance of collaboration.

project and provided the automation solutions. CRCMining worked on equipment condition monitoring to develop proof-of-concept longwall automation technology. This underwent full trials at Beltana and Broadmeadow with a smaller trial at Grasstree.

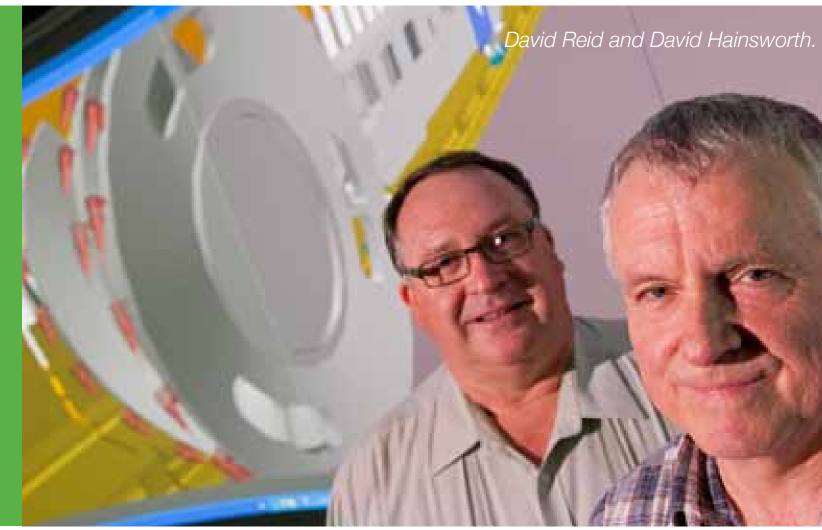
"The aim of the project was to fully automate a face to the level of on-face observation, not to get people off the face altogether, because we realised someone had to be there to look at the process and make adjustments when necessary," said Mick Kelly, who was Mining Manager at CSIRO at the time and Project Leader.

Stage two, awarded to CSIRO in 2005, produced a commercial prototype automation system comprising a shearer position management system; automated face alignment (which ensures the correct horizontal alignment of the longwall face); and inertial navigation system-based horizon control (which ensures the shearer's cutting drums follow the seam accurately).

Site support and project champions are integral to the success of any ACARP project. Xstrata Coal Principal Engineer – Electrical Peter Henderson acted as an interface between the researchers and the guys at the coal face, and was instrumental in gaining original equipment manufacturer (OEM) buy-in. He advocated a shift to automation in numerous forums. He also provided OEMs with commercial impetus for working with the project to provide industry-standard control system and software interfaces between their equipment and CSIRO's technology.

Longwall automation was identified by ACARP's Underground Committee as an initiative that warranted a significant investment.

> "The beauty of this system is that you can bury the inertial navigation unit deep inside the shearer and it's pretty much invulnerable."
> - David Hainsworth


David Reid and David Hainsworth.

Xstrata Coal released its 'landmark-based' longwall automation specifications for the Blakefield longwall into the public domain, and these specifications have been widely used across the industry in setting the criteria for new longwall equipment. According to CSIRO, today around 50 per cent of Australian longwalls have introduced LASC (the commercial longwall automation system) or have included it in their next longwall tender specification.

Glenn Owens, the industry's first automation engineer, was another project champion. He was responsible for the successful introduction of the technology into BHP Billiton Mitsubishi Alliance's Broadmeadow Mine. Having moved on to Anglo American as Automation Specialist LW100, he is now transferring this knowledge and experience to other sites.

The longwall automation project exemplifies the importance of industry working collaboratively to address an industry-wide issue. The major underground producers spent considerable time scoping the project and achieving alignment.

"Because we were going to ask for a lot of money – more than the Australian Coal Research Board had ever approved before – we needed to have a solid scope, a very clear vision of what needed to be done and a project management plan with three-monthly milestones for the researchers," said Guy Mitchell, Underground Committee Co-Chairman and now BHP Billiton Mitsubishi Alliance's Manager Underground Planning.

Peter Henderson believes this project has become the launching pad for further developments in automation.

"It showed that we could do things that we'd only dreamed of 10 or 15 years ago and that has given people the energy and drive to try and do even more," he said.

In 2004 Peter Henderson, Mick Kelly, David Hainsworth, David Reid, Paul Lever and Hal Gurgenci won the ACARP Research Excellence award for the longwall automation project.

BRAVE APPROACH PAYS PRODUCTIVITY DIVIDENDS

One of the bravest examples of industry support for an ACARP research project was BHP Billiton Mitsubishi Alliance's implementation of Universal Dig and Dump (UDD) technology across five of its BE1370s and Marion 8050 draglines in the 2000s.

What would you be prepared to do to achieve up to 25 per cent improvement in dragline productivity? Would you cut off the end of the boom and reposition the sheaves, remove half the rigging, relocate and shorten the hoist ropes on the bucket, cut the cable drum into two, and shut down the dragline for an extended period? Well that's exactly what BMA did.

In a real show of site commitment, Peak Downs Mine "chopped up" dragline 23 and conducted a full-scale pilot implementation of UDD technology, following successful one-tenth scale modelling work by UDD's inventor Jeff Rowlands and the Centre for Mining Technology and Equipment.

Making these modifications to a conventional dragline halves the weight of the rigging, enabling an increase in payload and allows more flexible digging and dumping inside the boom point radius. The automated hoist rope management system allows the bucket to be picked up as soon as it's full, improving cycle rate and productivity. The bucket's carry angle can now be controlled remotely.

"Because you can pick up the bucket as soon as it's full by virtue of the differential rope controls, you don't over drag the bucket, which can save five to 10 seconds. This translates to an increase in productivity of around 10 per cent if the operator utilises that advantage," Jeff said.

Prior to the changeover to the UDD system, the researchers monitored the performance of Dragline 23 for around 100,000 cycles over six weeks. After the changeover they monitored its performance in the same conditions for the same period of time and found a 24 per cent improvement for those trial conditions. Full implementation of the system took place over three years and achieved an incredible overall productivity increase of 15 per cent.

BMA incrementally introduced UDD to four other draglines – Dragline 17 at Peak Downs, Dragline 22 at Saraji, and Dragline 39 and Dragline 40 at Blackwater, achieving impressive productivity gains.

Former BMA Manager Research Alan Davies said a substantial benefit of UDD technology was the possibility of using it with a hopper crusher system,

The UDD installed on Dragline 23 at Peak Downs Mine increased productivity by up to 25 per cent.

providing much greater flexibility in repositioning the spoil. It also lent itself to automation, particularly on the swing to dump cycle, potentially leading to further productivity gains.

“BMA was probably the only operator in a position to take on this project due to the size of its dragline fleet. It had the most to gain and was able to shut down a dragline to do the conversions and take on board the risk of introducing this new technology,” Alan said.

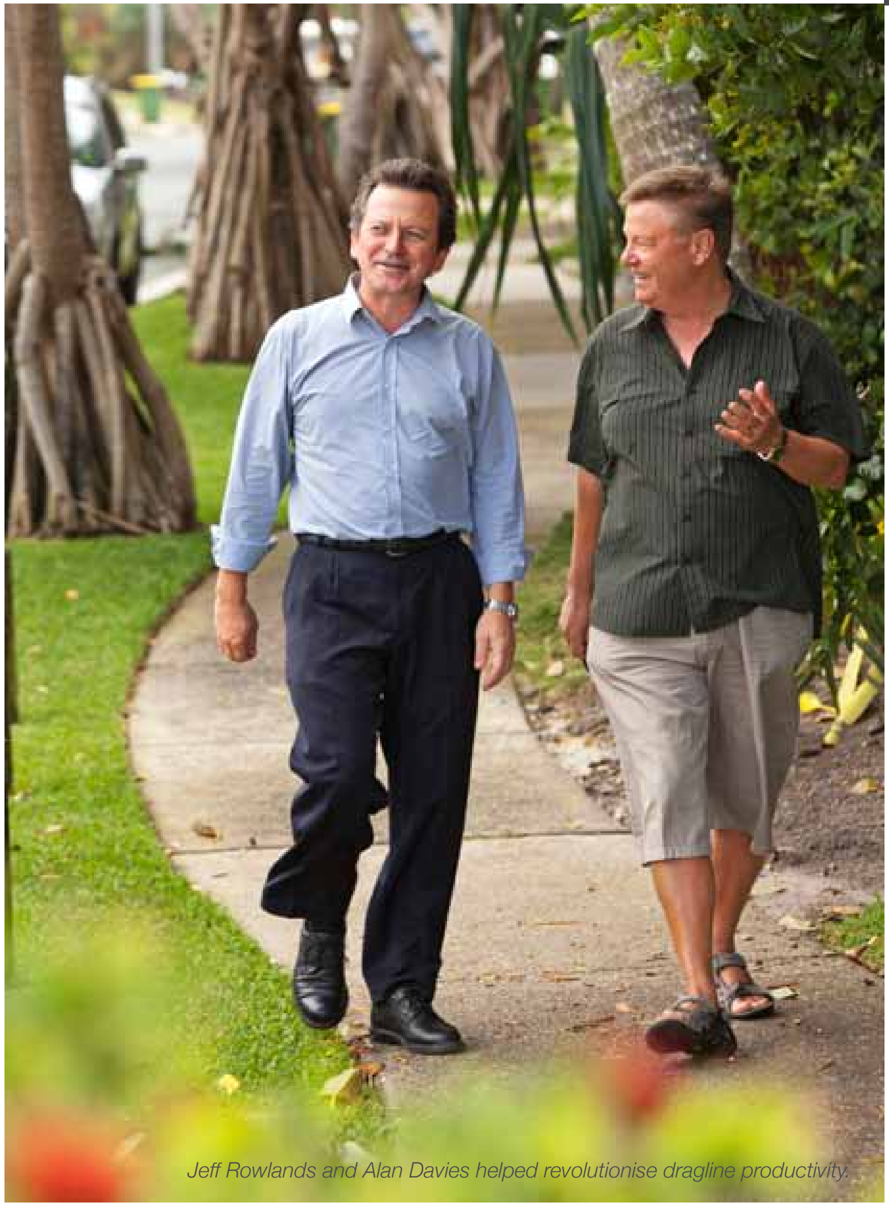
“There was also strong CEO support for developing this concept and the industry was in an optimistic mining cycle where companies were willing to make these sorts of investments.”

UDD faced a number of unforeseen challenges along the way including stress distribution issues with the boom and cooling issues with the swing motors. These were overcome through ingenuity and hard work.

Another issue was the difficulty in calculating productivity improvements.

“Even though we did end up with a system that is proven to improve productivity by 15 per cent, it was often very difficult on a day-to-day basis to compare one dragline with all other operating draglines. We used rigorous normalisation methods and qualifications of operating conditions to overcome this. However, this inevitably can be seized upon by critics as fudging or enhancing the data,” Alan said.

In 2004 Jeff was presented with the Clunies Ross National Science and Technology Award for “inventing a better way to control the buckets on the giant draglines used in Australia’s open cut mines.” These prestigious awards are presented annually for the application of science and technology for the economic, social or environmental benefit of Australia.



Jeff Rowlands and Alan Davies helped revolutionise dragline productivity.

8 FOSTERING INDUSTRY COLLABORATION

INDUSTRY ADDRESSES POOR ROADWAY DEVELOPMENT RATES

An industry-wide approach to addressing the failure of development rates to keep pace with modern Australian longwall systems is making inroads into the issue.

Since the introduction of mechanised retreat longwall systems in the early 1970s, production rates have been doubling every 10 years or so while gateroad development performance rates have remained fairly static. With best practice longwall mines approaching eight to 10 million tonnes per annum and ACARP initiating a feasibility study of 15 million tonnes per annum longwall mines, there was a heightened recognition of the need to improve roadway development performance.

In 2005 a Roadway Development Task Group (RDTG) was established that comprises nine member companies and represents around 90 per cent of the country's longwall production. The RDTG developed the CM2010 Roadway Development R&D Strategy, which is focused on supporting research into key enabling technologies of a high-capacity development system. These technologies include a remotely supervised continuous miner, automated installation of roof and rib supports, continuous haulage, and integrated face and panel services. The RDTG's vision is to achieve roadway development rates of at least 10 metres per operating hour and utilisation rates of 20 hours per day. Automation is critical to achieving this vision.

The RDTG meets regularly to review progress with researchers and advise the ACARP Underground Committee regarding research priorities. Members play a key role in reviewing progress of individual projects as part of an overall project management approach as well as liaising with mines and gaining site support for research, workshops and other initiatives.

The RDTG also runs roadway development operators' workshops in the Hunter Valley, southern/western New South Wales and central Queensland mining regions at least annually. Across the three regions the workshops are attended by 200 or more operators, researchers and OEMs involved in roadway development who discuss their experiences and identify areas for targeted research.

RDTG Coordinator Gary Gibson said while development and demonstration of the individual enabling technologies was well advanced, bringing them together as an integrated system was likely to take longer than first envisaged, and could require a fundamental redesign of the mining platform.

There is an industry-wide recognition that roadway development technology and systems require a step-change if they are to be able to effectively sustain higher capacity longwalls.

There is an industry-wide recognition that roadway development technology and systems require a step-change if they are to sustain higher capacity longwalls.

The Roadway Development Task Group at Ebenezer Mine, where the continuous miner guidance system on board the Phoenix was tested.

CONTINUOUS MINER AUTOMATION A STEP CLOSER TO REALITY

Automated continuous miners are a step closer to reality following the successful trial of a practical guidance system, which combines high performance inertial sensors with custom-developed radar.

Checking the continuous miner guidance system driving trials at Ebenezer Mine.

Further developing the work it did on the landmark longwall automation project to accurately measure shearer position in 3D, CSIRO Mining Technology Research group adapted its inertial navigation system to locate the position and orientation of the continuous miner. This is a significant breakthrough given the dynamic motion of the continuous miner compared with a longwall shearer that moves consistently along rails. This technology was originally adapted by CSIRO from the American military's inertial navigation system, which is used on missiles and tanks, and required the American Government's approval to use in Australia.

The continuous miner guidance system was installed on the Phoenix skid-steer test vehicle and tested on a remnant coal surface at the decommissioned Ebenezer coal mine in south-east Queensland. The overall aim of the project is to develop a mining navigation and control system necessary to deliver a remotely supervised, self-steering capability for continuous miners.

Project Leader David Reid said the final trial achieved a position error of less than 100 centimetres over a 2.5-hour mission, which followed seven segments of a two-heading mining plan with a total path length of more than 2.7 kilometres. In practice it is expected that the performance will be further improved by periodically zeroing the position error against physical survey points around every pillar length.

"For each of these experiments the Phoenix test vehicle control system was pre-programmed with the coordinates of the two-heading mining plan and the associated speed/direction profiles. The vehicle was then positioned at the starting point which the navigation system fully aligned and calibrated. The vehicle was then enabled to automatically navigate through the pre-programmed mine plan," he said.

"The results indicated that custom-designed radar technology can provide the accurate and timely velocity measurement necessary for an inertial navigation system to automate control of a continuous miner."

The Phoenix is fitted with an embedded computer so that it can autonomously navigate to a mission plan under closed-loop control.

The researchers are continuing to improve the underlying accuracy and reliability of this technology, which should lead to full underground trials on a production mining system. This work represents another step along the path to making roadway development safer through automation.

MINER AUTOMATION TRIALS ON TRACK TO IMPROVE SAFETY AND PRODUCTIVITY

Trials of a first generation automated roof and rib bolt and mesh handling system have achieved cycle times consistent with those required to support high-capacity longwall mines.

Developed by University of Wollongong researchers as part of ACARP's Roadway Development Improvement Project, the prototype system has undergone preliminary surface trials and will be fitted to a tracked platform for a full surface trial in July 2013.

Researchers are now carrying out a range of improvements to the system that will further reduce the cycle time; duplicate the automation for both left and right-hand sides of the machine; modify a tracked platform and adapt the bolt and mesh automation; and finally demonstrate the enhanced system for complete face support cycles in above ground trials.

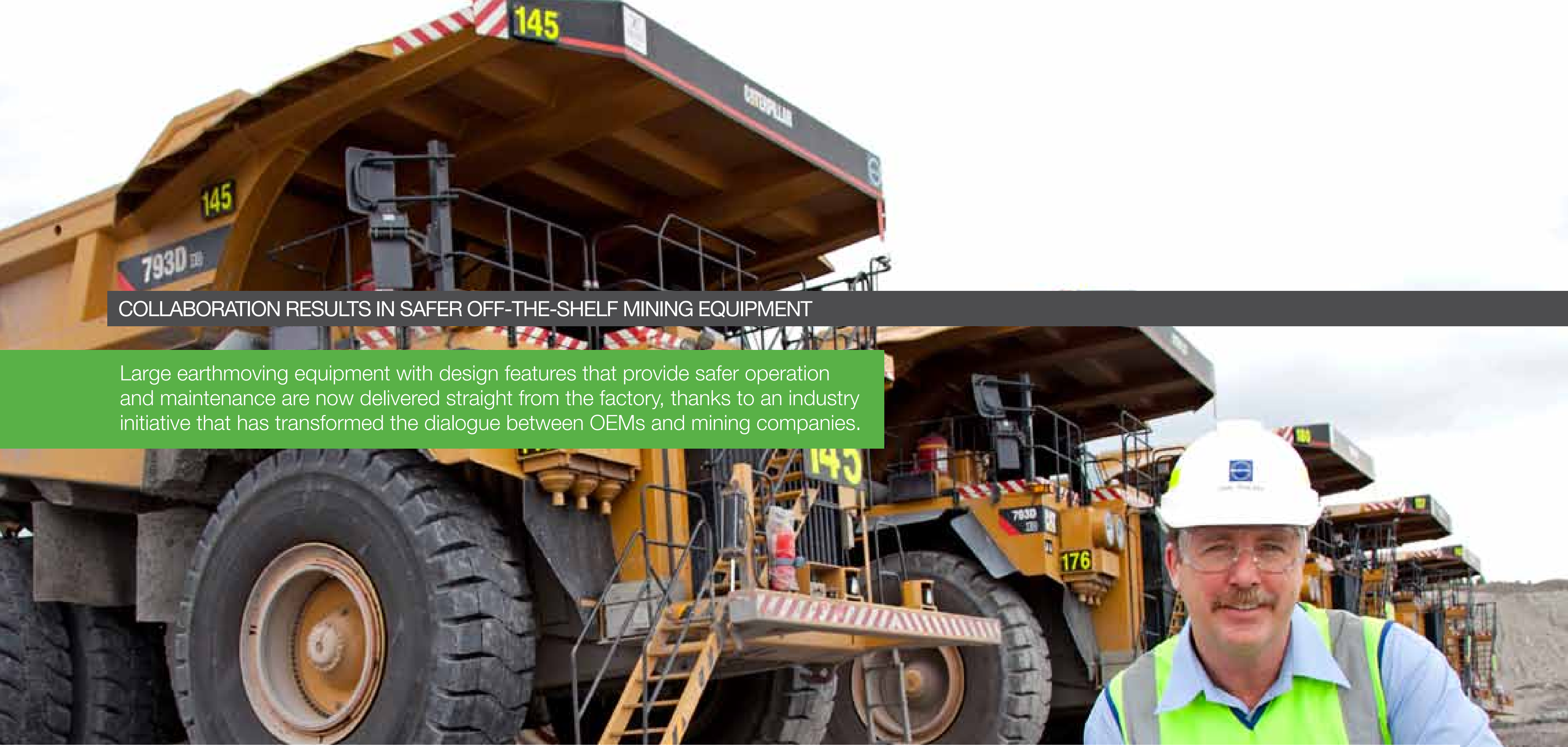
Project Leader Stephen van Duin said the project team had successfully demonstrated a method of transferring roof and rib mesh, bolts and washer bolts from the rear of the miner and automatically placing and fixing the components to the roof and ribs of the roadway using a laboratory simulation of a continuous miner.

“While compliance issues with the underground safety requirements are challenging, our greatest challenge was the lack of space. We were constrained by a minimum roadway height specification of 2.8 metres with a conventional continuous miner. Further, after consideration is given to conserving operator access for servicing and maintenance, the amount of space left to automate the handling of 23 items per metre of travel is very small,” he said.

“System complexity usually results when mechanisms are compressed into a space that is too small. Coming up with systems suitable for the small amount of available space without introducing great complexity was by far the greatest challenge in this project.”

A series of industry surveys identified manual strata support activities on a continuous miner as a major bottleneck that restricts improved production and affects the safety of operators. This prototype goes a long way to addressing that issue. At the end of the final surface trial, the University of Wollongong's major involvement in the project will conclude, with the findings and developed intellectual property handed over to the industry for subsequent commercialisation by a third party or parties.

Luke Meers and Stephen van Duin with the laboratory simulation of a continuous miner.



COLLABORATION RESULTS IN SAFER OFF-THE-SHELF MINING EQUIPMENT

Large earthmoving equipment with design features that provide safer operation and maintenance are now delivered straight from the factory, thanks to an industry initiative that has transformed the dialogue between OEMs and mining companies.

Fourteen mining companies representing a significant share of the global market are working collaboratively through the Earth Moving Equipment Safety Round Table (EMESRT) to discuss health and safety problems related to inadequate equipment designs. With a long history of stipulating solutions on inadequate OEM designs rather than working with them to change the base design process, mining companies clearly needed to adopt a new approach. They are now sharing information on how equipment is operated and maintained on site and human factors issues that arise during these processes directly with designers. Having this practical, problem-based information helps design engineers address the safety issues during the design and manufacture of equipment.

EMESRT was initiated by a small group of Australian mining industry people who engaged Jim Joy at the Minerals Industry Safety and Health Centre (MISHC) through seed funding from ACARP. Working with key industry people, MISHC developed the OEM engagement process which was finalised in 2006. Since then EMESRT has been industry funded. Its purpose is to "accelerate development and adoption of leading practice designs of earthmoving equipment through a process of OEM and user engagement". The advisory group sets the strategic direction and has established a vision, purpose and scope, and developed design philosophies on eight risk areas – working at heights, tyres and rims, fire, exposure to harmful energies, manual tasks, machine operation and controls, confined space and restricted work areas, and health impact factors such as noise, dust and vibration.

Each design philosophy specifies the problems encountered by human interaction with equipment and is supported by images that depict the risks to be mitigated. As a means of demonstrating the problems to designers, EMESRT has captured examples of leading practice solutions developed by mining companies and other third parties. The aim of the design philosophies is to provide information to help OEMs design equipment with risks mitigated using the ALARP (as low as reasonably practicable) principle.

EMESRT multi-company groups have conducted engagement meetings at the OEM factories in North America, Europe and Japan to enable greater participation by the designers. OEMs including Atlas Copco, Le Tourneau, Sandvik, Liebherr, Hitachi, P&H, Komatsu and Caterpillar are actively engaged with EMESRT.

Xstrata Coal representative Tony Egan, who was a founding member of EMESRT, has seen significant progress since the first meetings in 2006.

Tony Egan at Bulga Mine. The Cat fleet has manufacturer-installed safety features that meet EMESRT's design philosophies.

"What we're on about with EMESRT is actually solving the problem, not dealing with the symptoms after the equipment leaves the factory. This approach provides for a global, not regional solution, and reduces delivery time and costs. If you can remove a hazard altogether through factory design, all the better. With large mining trucks you can't change the fundamental design – you're exposed to working at heights – but through better design you can change the number of tasks that are done at heights. For example Caterpillar has gone right through its design to get routine tasks serviceable from the ground. An average-height person can now walk around under the truck and service the filters, do the test points and so on, so the risk of working at heights has been eliminated," he said.

Tony said engaging with the OEMs had improved two-way communication and overcome some long-term misunderstandings.

"When we began, a lot of equipment that came out of the factory couldn't be used safely because it didn't adequately control the risks for users and, therefore, did not meet our safety standards and often the regulatory requirements. The OEMs' factory-based designers used to ask us why we modified their equipment because they didn't understand the problems we encountered at site," he said.

EMESRT has developed a draft evaluation tool for manufacturers to identify the critical operation and maintenance tasks associated with their equipment in relation to the eight key risk areas. Manufacturers need to specify the design features they have developed to control or mitigate the risks identified. This tool – the EMESRT Design Evaluation for Equipment Procurement – has been distributed to seven major manufacturers of mining equipment for feedback.


Jim Joy ... immense opportunity to design safer mining equipment.

JKTech Manager Risk Management Services Jim Joy provides human factors expertise to the group, and helps coordinate the OEM engagement tours and facilitate the meetings. He also manages the MISHC resources provided to EMESRT.

"EMESRT is an immense opportunity for the mining industry to move ahead rapidly in terms of changing some of the classic risks that exist by recognising that a significant portion of them are about the design of the equipment," he said.

"I think it's important to understand that it's an immense change too. Most of the people on the advisory committee certainly recognise that nothing happens overnight. It's a journey, a maturity journey with the OEMs which will evolve over time."

Griffin Coal Mine.

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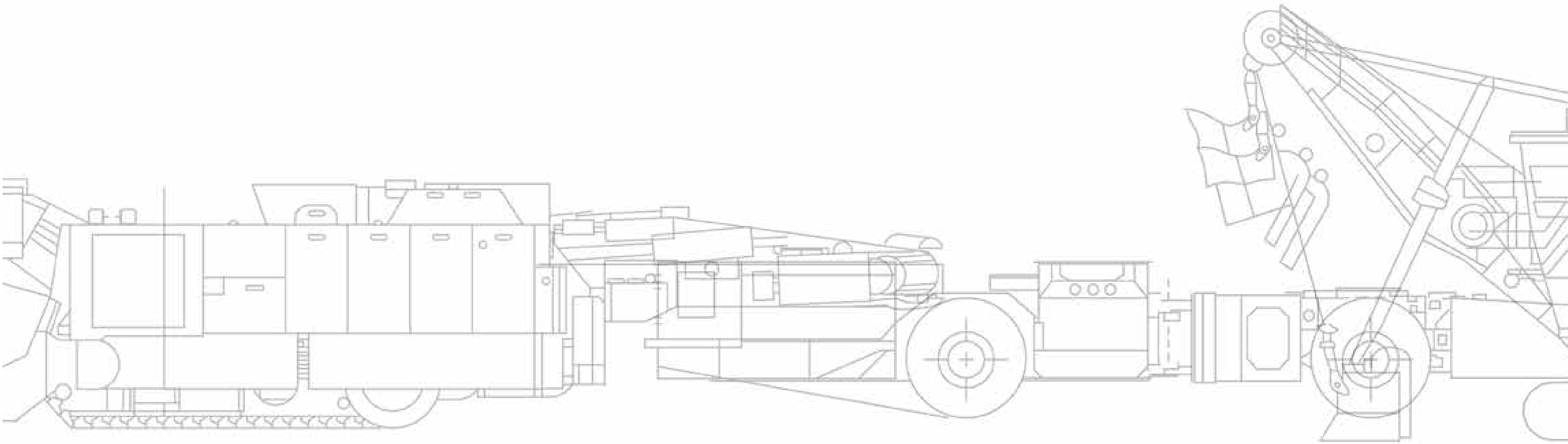
ACARP EXCELLENCE AWARD RECIPIENTS

Rao Balusu, CSIRO
Phil Bennett, ALS Coal
Jack Brady, Simtars
Robin Burgess-Limerick, Burgess-Limerick & Assoc
Agi Burra, Xstrata Coal
John Carras, CSIRO
Greg Collecutt, BMT WBM
Richard Danell, BHP Billiton
Ray Davis, Simtars
Daya Dayawansa, MTI
Larelle Fabbro, CQU
Bruce Firth, CSIRO
Kevin Galvin, TUNRA
Patrick Glynn, CSIRO
Julian Greenwood, SkillPro
Hal Gurgenci, CRCMining
David Hainsworth, CSIRO
Ross Hardie, Earth Tech Engineering
Peter Hatherly, CRCMining
Peter Henderson, Beltana Highwall Mining
Nigel Holmes, Holmes Air Sciences
Peter Holtham, JKMRC
David Humphreys, SkillPro
Charles Huxtable, DP&WC
Colin Jacka, CSIRO
Andrew Jonkers, JKMRC
Jim Joy, SMI UQ
Dan Kay, Mine Subsidence Engineering
Mick Kelly, CSIRO
Gul Kizil, SMI UQ
Paul Lever, CRCMining
Sue leveritt, SMI UQ
Mingfei Lou, Vipac
Geoff Lyman, JKMRC
Ross McAree, CRCMining
Rob Neale, New Hope Coal
Stuart Nicol, CSIRO
David Noon, CSSIP
Graham O'Brien, CSIRO
Michael O'Brien, CSIRO
David Proud, BMT WBM
David Reid, CSIRO
Alan Richards, Terrock
Bruce Robertson, Anglo Coal
Abouna Saghafi, CSIRO
Richard Sakurovs, CSIRO
Jim Sandford, Xstrata Coal
Arthur Waddington, Mine Subsidence Engineering
Louis Wibberley, BHP Research

Graduate Mining Engineer James Royal checks the operating status of the longwall at the control and monitoring enclosure.



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