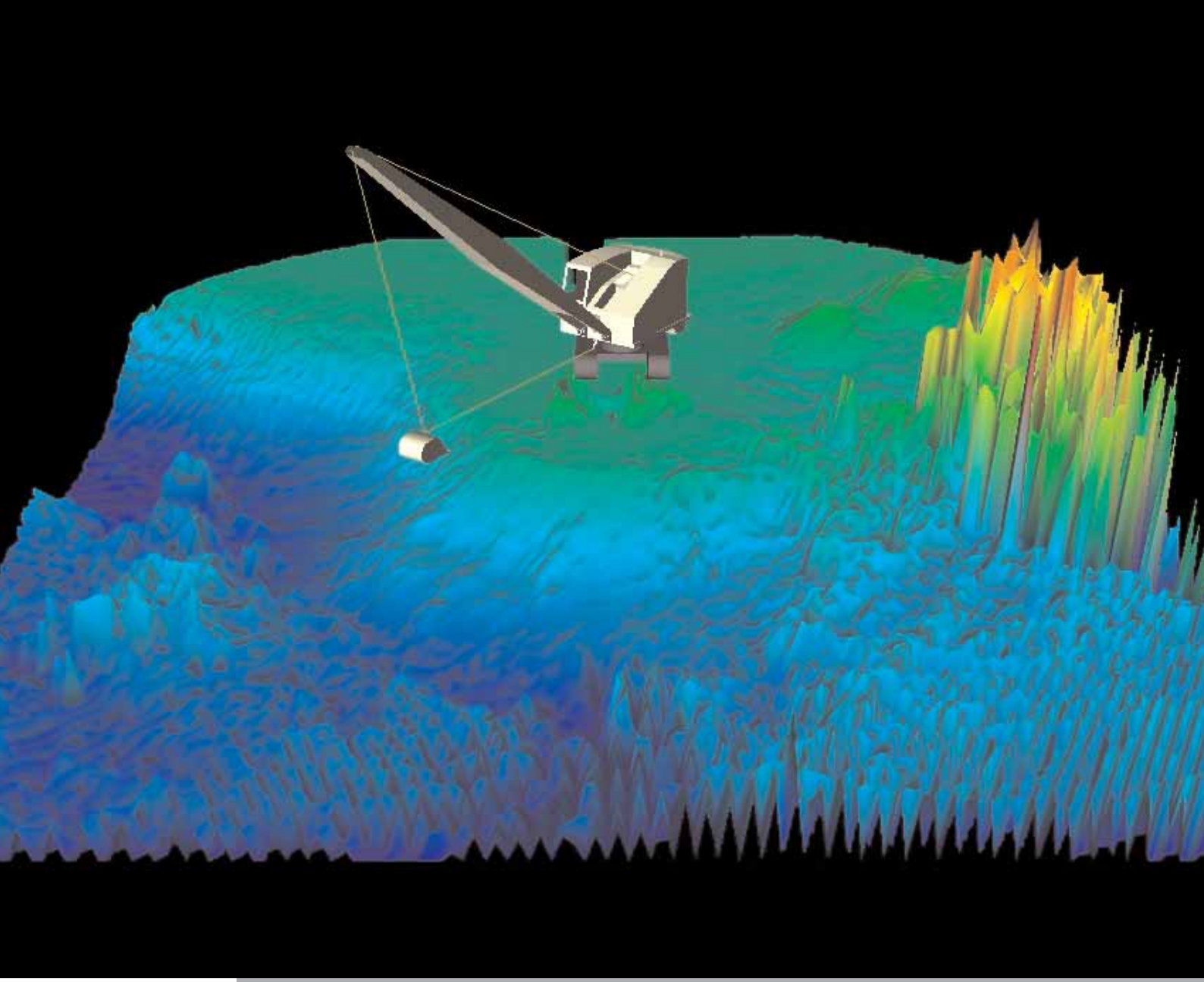

CSIRO

QCAT Annual Report 2005-06

Queensland Centre for Advanced Technologies

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Government occupants

CSIRO

Energy Technology
Exploration & Mining
ICT Centre
Manufacturing and Materials Technology
Minerals

Joint Venture

Centre for Low Emission Technology

Cooperative Research Centres

CRC for Cast Metals Manufacturing (CAST)
CRC for Coal in Sustainable Development (CCSD)

Commercial occupants

Advanced Mining Technologies Pty Ltd
Alcan Queensland R&D Centre
Applied Mining Technologies Pty Ltd
Australian Centre for Minerals Extension and Research (ACMER)
Cheron Group
Coal Augering Services
ComEnergy
GeoTek Solutions
Instinct Television
Jenkins-Kwan Technology Pty Ltd
LAADtech

Front cover image is a Digital Terrain Map (DTM) created on-line from a laser range-scanner mounted on the dragline's boom tip. On this particular dragline, these DTMs are then used by an operator in a remote control room to plan the excavation, which is then executed autonomously by the dragline's onboard computers.

Mission

The Queensland Centre for Advanced Technologies will be recognised for the excellence of its contribution to the mining, energy and manufacturing industries.

Our mission is to generate products and processes of high value to Australia's mineral, energy resources, and manufacturing industries with particular focus on those resources and industries located in Queensland.

Goal

The Queensland Centre for Advanced Technologies is a world class facility for research and development for the mining, energy and manufacturing industries.

Our goal is to increase the international competitiveness and efficiency of Queensland's and Australia's resource based and related industries.

History

The Queensland Centre for Advanced Technologies is a collaboration between the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the State Government of Queensland. The establishment of the Centre flows from an agreement between the Australian and Queensland Governments in 1990 to expand and diversify the research and development activities undertaken by CSIRO in Queensland. The Centre commenced operation in 1992 and was officially opened in 1993. Following the construction of new facilities, Stage Two was opened in 2000. Planning for Stage Three expansion is already under way.

CSIRO

Queensland Government

QCAT Annual Report 2005-06

Foreword

The Australian resources industry continues to rank among the best in the world. Australian Bureau of Statistics reports from 2004 indicate that Australia has the world's largest demonstrated resources of brown coal, lead, mineral sands, nickel tantalum, uranium and zinc. In 2005–06 Australia's mining exports were worth $57 billion, up $15 billion from the 2004–05 year.

The mining and minerals processing industries are also of significant importance to the Queensland economy. Queensland is the national leader in the production of base metals (copper, lead and zinc), and the world's largest exporter of seaborne coal. In 2003–04, minerals and processed minerals made up roughly half of Queensland's overseas exports. These resources are valued at $10.9 billion. The resources industry continues to grow, providing about 86,000 Queenslanders with positions in exploration, mining, processing, rail transportation, port facilities and power generation. In 2006–07, our state's resources industries are expected to contribute $1.52 billion in revenue to the state's economy.

Strong investment in world class research and development (R&D) is the driving force behind Australia's forefront position in the global resources industry. R&D funding in the mining industry has more than doubled in the past ten years with $780 million committed to R&D in 2004–05.

The Queensland Government is committed to maintaining its leadership in the global resources sector. The Queensland Centre for Advanced Technologies (QCAT) was established as a partnership between the Queensland State Government and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) with the goal of increasing the international competitiveness and efficiency of Queensland and Australia's resource-based industries.

QCAT is an excellent example of our State Government's Smart State agenda in action. It has evolved into an internationally recognised facility that provides outstanding R&D for Australia's exploration, mining, minerals processing, energy technology and manufacturing industries.

There is a strong culture of innovation and entrepreneurship at QCAT. Its focus on technology transfer has seen a flow of high value products and processes enter the resources sector. The expertise available at QCAT, combined with an emphasis on collaboration and industry engagement, has attracted centres of the calibre of Alcan's Queensland Research and Development Centre (QRDC), opened in July 2005.

QCAT is a tangible outstanding example of collaboration between the Queensland Government, CSIRO, industry partners, universities and research organisations. The Queensland Government is proud to have played a part in the development of QCAT and delighted with the excellent quality of work emerging from the facility. I commend QCAT for the role it plays in strengthening Australia's position in the global resources sector and advancing Queensland's major industries which provide jobs and earn valuable revenue for the State.

John Mickel

Minister for State Development, Employment and Industrial Relations

Executive Manager's report

QCAT began operations in 1992 with a mission to provide high value products and processes to Queensland's resources industries. It has developed into a world class multi-disciplinary establishment.

An independent operational status review conducted by Argyle Corporate Advisers in November 2005 stated that QCAT is now the principal single centre in Australia for research and development for the resource industry and it is regarded as a world leader in this field.

The QCAT Stage 3 expansion is now on the horizon and will provide Queensland's mining, minerals processing, energy and manufacturing industries with an even greater resource base to draw on.

Witnessing the flow of technologies and processes into industry has been one of the most exciting parts of my involvement with QCAT. It has given me a great sense of satisfaction to see our researchers engaging with industry partners to turn novel concepts and new and emerging technologies into real world solutions.

For example, QCAT's award winning longwall automation research which began in 1995 has developed a number of longwall automation systems. This year these systems have been rolled out to two mines, with a third to follow and the commercialisation process is well under way.

Research conducted at QCAT into underground coal gasification began in 1996. This research has successfully culminated in the initiation of a joint venture between CSIRO and Metex Resources Limited called Carbon Energy. The joint venture will begin with a landmark Australian demonstration of the coal gasification technology.

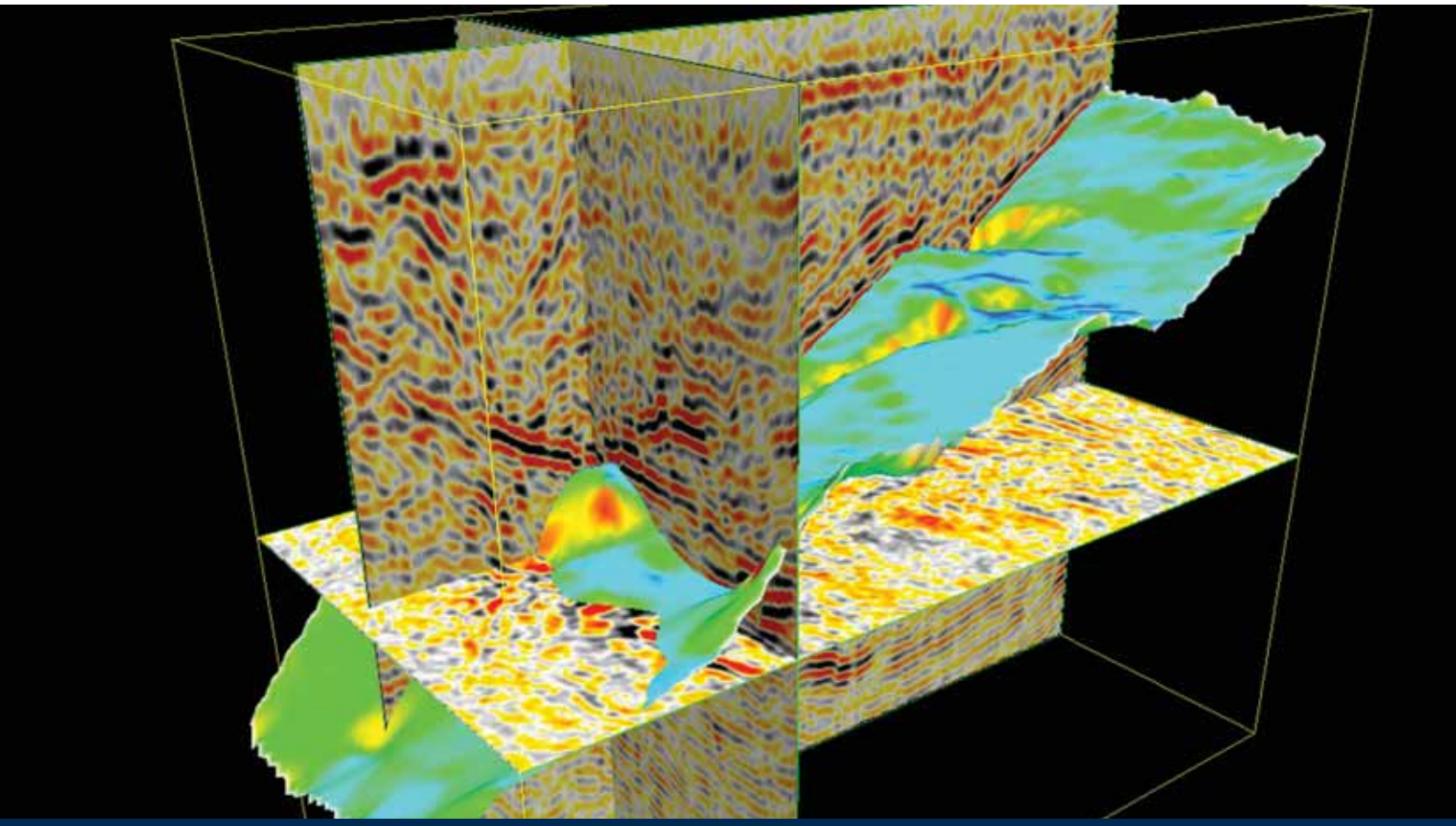
This is my last report as QCAT Executive Manager. My personal involvement in underground coal gasification research and the resulting joint venture will see me retire from CSIRO to take up a new position with Carbon Energy. This transition marks the beginning of a new phase of my association with QCAT. Carbon Energy will be located in QCAT's Technology Transfer centre where we can maintain a strong collaborative connection to the wealth of resources, know-how and cutting edge science available at QCAT.

I have been involved with QCAT since its inception as a Queensland State Government – CSIRO collaboration. QCAT has evolved into world class facility, internationally recognised for its application of leading science and engineering know-how to the advancement of the Australian resources industries.

I look forward to continuing this exciting association.

Dr Cliff Mallett
Executive Manager
Queensland Centre for Advanced Technologies

Geoscience



Over 60% of the technical problems experienced by new and existing mine operations can be traced to decisions made on the basis of geoscience inputs and interpretations.

Ongoing improvements in safety, reliability and cost effectiveness will rely on improved technologies and systems for understanding these inputs in relation to the mining and beneficiation process.

Mining Geoscience

The fundamental objective of mining geoscience is to provide solutions that reduce uncertainty associated with knowledge of the minescale geological environment. CSIRO focuses on five key areas of uncertainty associated with coal/ore and rock characterisation for mining.

Borehole logging

Research at QCAT on borehole and offline logging technologies has applications in all commodity areas — coal, iron, copper and other base metals.

The prompt gamma neutron activation analysis (PGNAA) logging system has been able to provide quantitative elemental information for a wide range of elements for different commodities. A proposal has been developed to combine this capability with other complementary technologies to develop a trace element tool that will achieve sufficient sensitivities for key elements needed by mining companies.

The group is expanding form its traditional area of borehole logging into the area of off-line analysers that can be used to process representative samples at various areas within the plant. As plants have the need for faster turnaround times than is currently provided by laboratory measurement, offline analysers can play an important role in improving analysis turnaround time and process efficiency.

The LogQA software prototype developed as part of an Australian Coal Association Research Program (ACARP) funded project on quality appraisal for geophysical borehole logs, provides an efficient means for identifying suspect borehole logging data from hundreds or even thousands of boreholes and allows problematic logging data to be rectified or removed from the processing stream. This research was supported by Fullagar Geophysics Pty Ltd and Borehole Logging Consultancy Services.

Coal Characterisation

Coal characterisation research addresses specific issues across the coal chain, from exploration through mining, coal processing and transportation to coal utilisation.

Recent ACARP-funded research has demonstrated that grain composition (maceral proportions) as well as grain size and density information obtained using optical imaging techniques can benchmark flotation response. The outcomes of this work have been used to develop a cross-divisional bureau service to benchmark and optimise coal flotation performance for Australian and international clients.

Recently completed research in coal handleability has resulted in improved coordination between the mines and Queensland Rail, to maximise the proportion of sticky coals that are carried in the trains. A follow-on ACARP project developed a reliable handling index that can be used to predict whether handling issues are likely for different coals. Thirty-three Australian coals were assessed and an advanced data analysis approach (self organising maps) was used to determine the relationship between coal properties and handleability.

CSIRO is working with the Julius Kruttschnitt Mineral Research Centre and Jenkins Kwan Technology to integrate optical and scanning electron microscopy information to provide compositional information on the organic and mineral phases in individual coal grains. This ACARP-funded research will develop a new characterisation capability to optimise coal usage in existing (i.e. power stations, coke making) and emerging (i.e. coal gasification) technologies.

3D imaging and data analysis

Sirovision® is a high precision 3D imaging technology that supports fast, accurate geotechnical and geological mapping of rock and terrain surfaces in 3D. It has significant implications for mine safety, as detailed spatial and orientation information can be collected without staff positioning themselves in high-risk situations.

Further development of the system has focused on extensions to open pit applications, structural modelling and slope stability analysis and enhancements to the data computation algorithms. An underground version developed at the Telfer underground mine in collaboration with Newcrest Mining is now available. We have tested a version that autonomously analyses mine walls, alerting operators if necessary.

On the commercialisation front, the Surpac Minex Group and Datamine Software Limited have been appointed as non-exclusive resellers and over 60 licences have been sold domestically and internationally.

Microseismics

The development of real-time microseismic monitoring for Australian coal mines has made significant progress. This will allow the location of rock fractures and the prediction of impending hazards such as roof falls, rock bursts, water ingress, working area stability, fault reactivation and gas and steam emission.

Research has focused on the development of a multi-channel and intelligent microseismic data acquisition system and wireless transmission of seismic data from sensors to the central mine office. Online data processing and result visualisation are also under development.

A new research project was set up to evaluate and develop seismic tomographic technology to map stress conditions and geological anomalies in the roof rocks ahead of the face, using longwall shearer and microseismic events as the sources and geophone arrays deployed along the roadways. It is expected that this technology will enable mining engineers to foresee mining hazards during mining. Data from the first trial at Beltana mine is being processed.

Integrated Geoscience Data Analysis

CSIRO Exploration and Mining has continued with its development and demonstration of data mining applications centred on the self organising map approach. Our predominantly self organising map-based methods allow an integrated approach to interpretation and visualisation that can assist in investigating relationships (cause and effect) and ideally, be predictive about outcomes based on existing data. These data mining methods are available to assist in understanding the relationships both within and between diverse data sets.

Self organising map data mining technology has been developed and applied to a range of mining applications including:

- Identification of subtle lithological signatures and improved rock strength estimation from multi-parameter downhole geophysical logs.
- Assessment of geological controls on gas content and composition in the Sydney and Bowen Basins.
- Development of a new structural model integrating multiple geological datasets with a detailed interpretation of depth-converted 3D seismic data for BMA's Goonyella–Riverside Expansion Project. The outcomes highlighted the detailed 3D geometry of a complex thrust fault system.
- Ongoing development of a new structural model for the Baralaba Coal Measures of the eastern Bowen Basin for Anglo Coal Australia. The structural model links the local mine-scale fault patterns to regional structural controls, forming a framework for better understanding of the controls on coal seam gas production by medium radius drilling technologies.

Mining

CSIRO Exploration and Mining, CSIRO Manufacturing and Infrastructure Technology and the CSIRO ICT Centre work together to provide applied technology solutions to major issues confronting the coal and metalliferous mining industries.

Mining is Queensland's largest export industry. In 2003–04 alone, mining exports totalled $10.9 billion, or roughly half of Queensland's total. In the same period the Queensland Government collected $611 million in royalties from mining. Mining has evolved into an extremely sophisticated, 21st Century industry and Australia is a global leader in developing new technologies.

Australia also supports a mining technology services industry of more than $3 billion. Computer and communication technology is used throughout for mathematical modelling, mine design and optimisation of all process stages.

Coal mining

Queensland is the largest seaborne coal exporting province in the world. From total production of 160.06 million tonnes of saleable coal in 2003–04, Queensland exported a record 134.98 million tonnes valued at approximately $7.2 billion. Demand for Queensland coal is continuing to grow.

Longwall Top Coal Caving

CSIRO in conjunction with Yankuang Mining Group (China) and the University of New South Wales has assessed the application of longwall top coal caving (LTCC) to Australian conditions. More recently CSIRO has completed an ACARP-funded research project into the key elements for the implementation of the LTCC in Australia. This resulted in the development of new tools to enable the accurate characterisation and assessment of caving conditions in conjunction with the impacts of ventilation, gas, dust and spontaneous combustion on LTCC operations. With the commissioning of the first LTCC face in Australia to occur in September 2006 in the Hunter Valley of New South Wales, CSIRO has been working with the mine owners, Yancoal Australia, on various aspects of the mine's development.

Inertisation

The frequency of fire incidents in longwall panels has increased significantly in recent years, leading to production losses and safety risks for a number of coal mines in Australia and around the world. To address this major industry issue, CSIRO in conjunction with ACARP and the Australian coal industry has developed optimum proactive inertisation strategies to reduce the risk of heatings/fires in underground longwall mines.

Field studies carried out at two mine sites demonstrated that the proactive inertisation strategies developed were highly successful in achieving effective inertisation and reducing the risk of heatings/fires in longwall goafs during the field demonstration periods. Research in this area is crucial for a number of existing and newly developing underground coal mines in Australia.

Transparent Flameproof Enclosure Cover

A transparent flameproof cover has the potential to provide improved equipment diagnosis and preventative maintenance capabilities that will ultimately improve mining machine availability in Australia's underground coal mines.

The project is in its final stage and two covers of dimensions 860 mm x 690 mm have been manufactured and pressure tested. A finite element analysis of the steel frame has been completed and a revised design for the steel frame section of the cover has been developed.

Several important milestones have been achieved, most notably the development of practical design guidelines for large transparent flameproof covers, which will prove a useful tool for Australian flameproof manufacturers who wish to adopt this new technology.

CSIRO has applied for Australian patent protection for the new technology. The final project report is being prepared and the fundamental principles and construction techniques established will form the basis for large transparent flameproof cover designs of the future.

Metalliferous mining

Queensland has a wealth of mineral bodies. The state yields 30 mineral commodities and is the national leader in the production of base metals (copper, lead and zinc). Total metalliferous mineral production in Queensland in 2003–04 was valued at $4.8 billion, up from $3.5 billion in 2002–03.

Metalliferous mining research at QCAT includes work in rock cutting, geomechanics, and new mining techniques. These activities involve staff from CSIRO Exploration and Mining, CSIRO Manufacturing and Infrastructure Technology and the ICT Centre.

*SMART*CUT*

SMART*CUT technology provides effective cutting tools for mining and civil industries and helps to improve productivity and reduce operating costs. It uses a CSIRO world-wide patented bonding technology to join thermally stable diamond composite cutting elements to the tool body. The technology can be applied to mechanical excavation, rock cutting, drilling and sawing.

It provides an economical and effective solution for cutting hard rocks that previously could not be cut by conventional tools. It also provides significantly reduced tool wear rates and increased tool life, compared with conventional tools. The ability to economically cut hard rock will now enable new mining methods.

In collaboration with Placer Dome, CSIRO had completed extensive laboratory cutting trials with SMART*CUT picks. The trials were conducted with various rocks, pick sizes, table speeds, depth of cuts

and cutter head rotating speeds. The trials, which showed that hard rock with an unconfined compressive strength as high as 260 MPa can be effectively cut with SMART*CUT picks, have laid down a solid base for future development of SMART*CUT tools. CSIRO will soon join with mining companies for field trials of SMART*CUT picks.

Sand Mining Systems

QCAT's involvement in mineral sands research began eight years ago with Sord Technologies, and has since grown to include engagement with AMIRA, Sord Technologies, Consolidated Rutile Limited (CRL), Tennant Isokangas and Iluka. Research began with Tennant Isokangas and CRL and addressed issues relating to the stability of mining slopes on North Stradbroke Island near Brisbane.

During the past year, two projects have been completed for CRL. The first was to install instruments and monitor the operation of a sand mining dredge on North Stradbroke Island and then to design a system for controlling the dredge by remote control. The project also defined and offered solutions to the issues that needed to be resolved and gave CRL the information required to decide whether to proceed with the conversion to remote control.

In collaboration with CSIRO Mathematics and Information Science (Melbourne) the second project delivered basic simulations and animations of sand falling down the mining face into the dredge pond. This provided CRL with an illustration and estimate of the nature and size of waves in the pond and the resultant movement of the dredge.

An inertial navigation sensor was built and delivered for Sord Technologies to trial with their prototype underground sand mining dredge (SORD and SHIELD). Iluka and CSIRO have developed and agreed on the scope for a range of research projects involving CSIRO researchers from QCAT and Melbourne.

Large Open Pit Mine Rock Slope Stability Project

CSIRO is internationally recognised for its expertise in the field of slope stability and open pit mining geomechanics. In 2004 the group initiated a major research project involving the stability of rock slopes in large open pit mines. The project, now at its midway point, aims to address critical gaps in the knowledge and understanding of the relationship between the strength and deformability of rock masses and the likely mechanisms of failure in large open pit mines.

The project has three objectives:

1. Publication of an authoritative new generation pit slope design manual that links innovative mining geomechanics research with best practice in open pit slope design.
2. Research that provides vital new knowledge, and design criteria that describe the critical gaps in our current understanding of rock mass failure in large open pit mine slopes. This includes research directed at enabling the effective use of remote data acquisition methods, automated data analysis and interpretation methods, 3D modelling, simulation and design analyses, and uncertainty analysis.
3. Development of enhanced risk management criteria focused on the relationship between risk reduction and the uncertainties of slope design and its impact on mine performance.

The project is sponsored by eleven mining companies representing the majority of the world's production of diamonds and base metals. These companies are:

- Anglo American pl, London, England
- Barrick Gold Corporation, Toronto, Canada
- BHP Billiton Innovation Pty Limited, Melbourne, Australia
- Corporacion Naciónal Del Cobre De Chile ('Codelco'), Santiago, Chile
- Compania Minera Dona Ines de Collahuasi SCM, Iquique, Chile
- DeBeers Group Services, Johannesburg, South Africa
- Newcrest Mining Limited, Melbourne, Australia
- Newmont Australia Limited, Perth, Australia
- Xstrata Queensland Limited, Brisbane, Australia
- Debswana Diamond Co., Gaborone, Botswana
- RioTinto, Melbourne, Australia.

ROES™, a new non-entry mining method

Significant improvements to mining safety and efficiency can be achieved by using automation to remove people from hazardous areas. For hard rock mining, a non-entry, remote controlled method called ROES™ is being developed by CSIRO and a number of collaborative partners. ROES™ uses a new generation of remote controlled equipment to drill, load explosives and initiate blasts.

In traditional mining, underground roadways provide access to the ore body at a number of levels. However, with ROES™, one vertical shaft runs down through the ore body and an underground roadway provides access only to the base of the mining area. Automated equipment is lowered down the shaft to drill, load explosives and blast. The blasted ore is collected from the base. Because access is required only at the top and base of the mining area, mine

development costs are dramatically reduced.

Current estimates are that ROES™ will reduce mine operating costs by between 10 and 20 per cent. This will result in savings of up to $200 million a year in 18 target mines alone. It also means that at least $100 billion of currently sub-economic ore may become economic, creating large new reserves for Australia. When used in combination with methods such as block caving, ROES™ also has the potential to reduce some of the risk that such methods currently experience. In addition, the method is applicable to underground quarrying near cities.

CSIRO and Orica are working together on automated explosive loading and ROES™. A number of mining companies are currently assessing the advantages of ROES™ at selected sites. This follows earlier work by CSIRO and Curtin University, through the Western Australian School of Mines. Valuable strategic funding has also been provided by the Western Australian Government through the Australian Resources Research Centre.

Mining ICT & Automation

Information and Communication Technology (ICT) is a core enabling technology that flows through all areas of new developments in mining and plays a major role in research at QCAT. Australia has an enviable record in mining ICT. About 60 per cent of all mining software used throughout the world is developed in Australia.

CSIRO Exploration and Mining and the CSIRO ICT Centre collaborate on a number of projects. During 2005–06 the Autonomous Systems Laboratory of the ICT Centre has delivered field-proven robotics systems that provide the building blocks for future automation of mining equipment in surface and metalliferous underground operations. The Mining ICT and Automation group's ongoing emphasis on applied research and development has continued to produce novel and robust industrial solutions as well as stimulate new science ideas.

Automation and Sensing. (A&S)

The main goal of research into Automation and Sensing has been to develop a framework that links heterogeneous and potentially reconfigurable mining equipment working with minimal human operator intervention to accomplish major tasks in mining.

Tele-Robotics (TR)

The long-term goal of our tele-robotics research has been to develop technologies that allow operators to control remote equipment safely and efficiently. The scope of the work includes developing active and haptic controls for existing mining equipment and undertaking studies of current immersive technologies in other industries before the development of demonstration units for the mining industry

Excavation system for non terrestrial applications

The excavation system for non-terrestrial applications project has caught the imagination of many people, as it provides a window into the future for the mining industry. The project has developed automation and tele-robotic systems for a 1/7 scale dragline located at Redbank in Brisbane. The dragline is now capable of performing a semi-autonomous excavation under the control of a remote operator. The project is being conducted for a NASA/MIT consortium and is designed to demonstrate how an excavation could be undertaken on a non-terrestrial object such as the moon. The system is scheduled to be demonstrated from the United States in late September 2006.

The portfolio of projects undertaken through the ASL in 2005–06 is listed below, with indications of the core technologies deployed:

- Swing loader traffic management – (A&S)
- Rope shope automation – phase II – (A&S)
- Dragline digital terrain mapping – (A&S)
- Excavator guidance systems – 'dig to plan' assist systems (A&S)
- Excavation system for non-terrestrial applications (A&S, TR)
- Automated explosive emulsion for underground metalliferous mines (A&S, TR)
- Coal interface detector system – phase II – (A&S).

Landmark Longwall Automation

A significant component of coal mining research continues to address longwall automation. CSIRO's ACARP-funded Landmark Longwall Automation project successfully demonstrated new face alignment, horizon control, communications, geotechnical monitoring and information systems. A two year extension began in April 2005.

Major activities in the first full year of the extension project have been:

- The implementation of automatic face alignment systems on a production basis at Beltana and Broadmeadow mines.
- Further development of automatic horizon control employing inertial navigation system-based shearer position measurement, ranging from factory trials to underground production operation with two shearer manufacturers.
- The development of a longwall automation system to provide 3D visualisation of the longwall, including face equipment, geology, geophysics and other infrastructure.
- Further development and refinement of scanning laser-based sensors for accurate measurement of longwall position.
- The development of an across-face camera array for coal interface detection and face observation.

At the conclusion of this project, face alignment and horizon control systems will be mature technologies and new sensing, monitoring and information systems will be developed and demonstrated at the pre-commercialisation stage.

A parallel project has focused on commercialisation of the initial face alignment and horizon control outcomes of the longwall automation research. The selected route to market is via the major longwall equipment suppliers. Licensing and royalty terms with these commercialisation partners have been negotiated. In addition, procedures for the handover and ongoing support of project intellectual property have been developed. The first commercial products are expected by June 2007.

Mine Communications Information System for Real-time Risk Management

The project seeks to introduce step-change capabilities in the areas of real-time safety and operational management through information capture, integration and rules-based analysis. The intrinsically safe communications hardware developed will allow the world's underground coal mining industry to fully utilise the ethernet-based communications systems enjoyed for so long by surface and non-hazardous area industries.

The system will monitor several proprietary safety and productivity data capture systems (including proprietary supervisory control and data acquisition systems) over a fibre optic network, convert them into a common language, analyse the data as a whole and integrate the results. Data sources captured will include:

- ventilation monitoring and gas detectors
- coal seam gas drainage holes
- fires and spontaneous combustion
- roof-fall monitoring
- man and equipment locations
- operational and productivity data
- environmental monitoring.

Once integrated into a central database, the Nexsys Real-time Risk Management System will use a series of pre-set program rules to determine the real-time risk profiles present at the mine. Such analysis will allow for pre-emptive corrective and preventative action.

All data and risk analysis information together with the location of the workers will be displayed on a real-time, 3D graphic user interface that represents the real-time layout of the mine (or workshop) and can be viewed from any computer connected to the local area network.

The project will deliver:

- an IS certified (IEC Standards Ex Ia) auto-sensing fast ethernet switch
- an IS certified (IEC Standard Ex Ia) serial to ethernet protocol converter
- database connectors and integration software
- a commercial release version of the NEXSYS™ real-time risk management system
- Manufacture version of e-Reporting tablet and software system.

These combinations of ethernet-based hardware devices and real-time analysis software systems are currently installed in two Australian coal mines (in Qld and NSW) and are undergoing extensive field-trialling and validation. A third field trial installation is planned for a Japanese coal mine in November 2006, with future plans for installations in China and India.

Commercial agreements have been reached with an Australia manufacturer for the technology transfer of the hardware devices and negotiations are continuing for the commercialisation of the integrated software system.

Laser Scanning Technologies

Laser scanners are a relatively mature technology, but the full scope of their capabilities and potential applications have yet to be fully realised. Some of the group's successful and diverse applications of laser scanning technologies in the field include:

- An automated truck volume measurement system managed and supported as a commercial product both nationally and internationally through Transcale Pty Ltd.

- A real-time localisation system for measuring the position of a longwall shearer in the underground coal mining environment, a key component in longwall automation.
- A new system for automatically measuring the 'carry-back' of coal in Queensland Rail rolling stock, leading to significant improvements in transportation efficiency.

The key to the success of these systems is a fundamental understanding of the problem, followed by the design of a robust processing framework to provide the specific information. A range of new research opportunities involving automated profiling, navigation and stability monitoring for mining and automation are being pursued by the group.

Subsurface Imaging using Ground Penetrating Radar

Ground penetrating radar is an electromagnetic sensing technology that can be used to produce a pseudo image of the sub-surface. Ground penetrating radar has traditionally been used by expert operators in a survey-type capacity. A high level of expertise is required because of the very complex nature of signals produced by the radar. This signal complexity has long been a barrier preventing broader application of the technology.

The signal processing expertise in the CSIRO Mining ICT and Automation group is being employed to overcome this fundamental barrier. This is primarily being realised through the development of new intelligent radar processing methods.

Our strong industry links in mining underpin a number of new applications in strategic areas. Already a number of successful demonstrations of this technology have been undertaken. Ongoing development efforts are focused on providing new selective mining capabilities and new safety capabilities through sub-surface roadway monitoring systems. If the radar signals can be successfully processed to automatically extract the required information, then ground penetrating radar has the potential to be a key sensor for mining automation.

SLIC (Simultaneous Localisation, Identification and Communication): Radar Imaging Technology

We are investigating integrated systems that combine the traditional localisation capability of radar and laser scanning systems with the communications capabilities of Wi-Fi networks. The goal is a new level of sensor–machine integration. Communication and control systems will use the information provided by sub-surface and other sensors to intelligently guide the mining process. The data supplied by these various sensors will allow guidance on the basis of interpreting probabilities, unlike the traditional control systems of the past, which use binary logic. SLIC algorithms will control the movement of mining machinery safely and efficiently while still learning about the destination: a truly self-guiding process.

Because some of the hazards associated with mining are so great (rock fall, tunnel collapse, explosives placement, hidden water volumes, etc.), it is necessary that the human operator be removed from the immediate vicinity of mining. These dangers, plus the complexity of the information to be interpreted, demand an automated solution. But the mining process is more than a single machine working alone. To truly take advantage of the new information available at the cutting edge of the mine, the entire process must be able to anticipate control decisions. This requires a globally coordinated approach to the automation of multiple individual systems that will depend on developments in networking technology, broadband wireless systems, distributed control elements, and enhanced rule-based engines.

Collision avoidance

Research into collision avoidance technologies for mine haul trucks may lead to significant benefits in safety at mine sites. At QCAT research into this area has progressed over a number of years and technology is now licensed to Advanced Mining Technologies. This year, successful vehicle trials of a radar based system were held on site at QCAT. The ACARP approved project is a collaboration with industry partners. Preparations are underway for mine trials in November 2006.

Processing

Innovative and cost effective processing of Australia's mineral wealth is essential to maintaining the competitive position of the Australian mining industry. Researchers at QCAT are conducting research and development to assist the industry in Australia and overseas.

Iron ore and non-ferrous mineral processing

The Australian iron ore industry is experiencing unprecedented growth, largely driven by demand for raw materials from the Chinese iron and steel industry. In response, iron ore companies are demanding more from their existing resources and equipment and are developing a wide range of new ore deposits. CSIRO is continuing to work closely with the industry to help meet these needs. We provide unique expertise, including detailed mineralogical, beneficiation and agglomeration evaluations of new and existing ore types and deposits, and predicting and optimising the processing performance of sinter, pellets and lump in blast furnaces and other downstream processes.

The Australian non-ferrous mining industry is also buoyant and under similar pressure to optimise existing operations and reduce costs, particularly in the energy-intensive grinding area. QCAT research staff are involved in optimising the performance of SAG mills and high pressure grinding rolls, as well as stirred mills for ultra-fine grinding.

Predicting processing performance

CSIRO continues to investigate the processing characteristics of new and existing ore deposits as well as new ore blends derived from these ore deposits. A major focus at present is the automation of ore characterisation and prediction of downstream processing performance by linking ore mineralogy and petrology to metallurgical performance, e.g., sintering properties. Other technologies developed by CSIRO for predicting processing performance include optical microscopy/computer-based image analysis and mineralogy-based models of a range of unit operations, such as hydrocycloning, magnetic separation and reverse flotation. These will ultimately speed assessment of the likely viability of new ore deposits by minimising expensive laboratory and pilot-scale research on ores that do not show promise. It will also allow more rapid assessment of processing options.

More effective beneficiation strategies

Alternative iron ore sources of lower grade ore containing impurities, such as Marra Mamba, high-phosphorus Brockman and Channel Iron Deposits, are being exploited to meet market demand from China. The need to develop more effective beneficiation strategies has triggered the establishment of an impurity removal project. The project runs under the Minerals Down Under major cross divisional program which underpins the future of Australia's iron ore industry. A range of new approaches is currently under investigation, including dry tabling, utilisation of a unique jig-wet high intensity magnetic separator and microbial induced flotation of alumina.

The current iron ore boom and shortfall in supply of traditional hematite/goethite ores has also created a strong interest in Australia's substantial magnetite ore resources. Characterisation and beneficiation research on magnetite resources, including a number in Queensland, is continuing. This work follows the successful commissioning of new laboratory and pilot-scale magnetic separation equipment. It has led to a better understanding of the beneficiation potential of magnetite resources, including magnetite tailings. This includes ways to target the removal of some of the minor elements that cause problems in subsequent pelletising and ironmaking operations.

Iron ore sintering and blast furnace burden characterisation

The sintering research conducted at QCAT continues to be pivotal to proving up new Australian iron ore resources for export. At the fundamental level, laboratory scale research is being conducted to understand and minimise the effect of increasing alumina and goethite in Australian ores on sinter quality and to better understand the fundamental characteristics of high phosphorus Brockman ores. The granulation characteristics of iron ores have also been investigated, with a particular focus on the interaction of size distribution and ore mineralogy. This is crucial, because as Australian iron ores become more diverse, we require a greater understanding of granulation properties and in turn their impact on sintering.

To enhance CSIRO's capabilities in evaluating the sintering behaviour of new and existing Australian iron ore deposits, the CSIRO state-of-the-art pilot-scale sinter rig (~80–100 kg samples) has been upgraded to accommodate sinter bed depths of up to 860 mm. Research can now be conducted into the effect of deep bed sintering on Australian iron ores. In addition, the CSIRO small-scale sinter rig (~5 kg samples) has been enhanced to enable automatic data logging and reduce heat losses to the wall of the sinter pot to improve the quality of sintering data.

In the blast furnace burden characterisation area, the CSIRO softening and melting furnace has been upgraded to allow improved data logging and better atmosphere control. Instrumentation has also been

added to enable measurement of waste gas concentrations, such as CO, CO_2, O_2 and H_2.

Iron ore pelletising

The CSIRO pilot-scale iron ore pelletising facility has been used over the past year for optimising balling, drying and induration of iron ore pellets, particularly for magnetite ores. Significant international interest has been shown in the new laboratory-scale infra-red image furnace at QCAT that is being used for determining reactions during the firing of iron ore pellets. A design study has also been completed for a major enhancement of the pilot-scale pelletising facility to incorporate a batch kiln. This will enable simulation of both straight-grate and grate-kiln-cooler pelletising operations and facilitate simulating the firing of Australian magnetite in grate-kiln-cooler pellet plants.

The Siro–Indur computer-based simulator developed by CSIRO is being used for optimisation of straight-grate and grate-kiln pellet induration. It has already been applied in Australia and North America, and there are potential applications in Brazil and China.

Plant optimisation

Research for the non-ferrous mining industry on SAG mill optimisation and both fine (<38 micron) and ultrafine (<10 micron) grinding is continuing. The three year extension of the AMIRA SAG mill project (P667A) to monitor mill performance via surface vibrations is nearing completion. A ruggedised industrial monitor with an inertial power supply for continuous operation has been developed and demonstrated at the Northparkes mine. An additional installation for one of the project sponsors is in the planning stage with more to follow. The monitor can track the toe and shoulder positions of the charge inside the mill as well as other operating parameters such as mill load. A proposal to extend the project for another three years to extract additional process information from the vibration signals in under development. The technique has also been applied to stirred mills with interesting results.

In the fine grinding area, a wide range of laboratory and pilot-scale stirred milling equipment from various manufacturers has been assembled at QCAT, including a tower mill, a Metso detritor and an IsaMill. This provides a unique capability for conducting side-by-side comparisons of the relative performance of these fine grinding machines, including mill wear properties and the performance of various fine grinding media.

The Centre for Sustainable Resource Processing

CSIRO continues to contribute to the research activities of the Centre for Sustainable Resource Processing, in collaboration with research staff and students from the Julius Kruttschnitt Mineral Research Centre. The main focus of the research is on eco-efficient liberation and comminution. The overall objective is to develop ways of reducing the total comminution energy at selected industry sites by 20 per cent or more. To improve overall plant efficiency, CSIRO has been quantifying the benefits of using more energy-efficient comminution equipment, such as tower mills and horizontal stirred mills, in different applications.

Standards development

Our researchers continue to play a leading role in the development of both International Standards Organisation (ISO) and Australian Standards for international trade in iron ore, base metals and coal. Current efforts are aimed at improving methods for the sampling of iron ores, coal and copper, lead, zinc and nickel concentrates, while new methods are under development for sampling slurries and smelter products and residues. Improved ISO methods for physical testing of blast furnace and direct reduction feedstocks for iron and steel making are also under development.

Coal processing

QCAT-based CSIRO researchers are working with the coal industry to improve the quality and competitiveness of Australian coal on international markets.

Supported by ACARP and the coal producers themselves, the group is developing components for the conceptual intelligent plant system. New hardware and software developments will allow a processing plant to know its current operational performance in real time, and how it compares with optimal standards. This will improve efficiencies and long-term operating costs in coal production plants.

Our researchers are also attempting to identify factors controlling the efficiency of fluid recovery, partition curves and magnetite recovery.

In addition, we are exploring the potential of electrical impedance spectroscopy as a new tool for monitoring unit operations in coal preparation plants, and new capabilities for optimising plant performance. A number of proof of concept projects were completed successfully with dense medium cyclones and coal flotation systems at the pilot scale. Industry funding has been obtained to continue the work with focused plant trials.

Manufacturing

Light metals are a vital sector of the Australian economy. Australia is the world's largest producer and second largest exporter of bauxite, the world's largest producer and exporter of alumina and the world's fifth largest producer of aluminium. The total value of all aluminium sector exports was over $7.8 billion in 2003.

Light metals engineering

Light Metals Fatigue

Recent research at QCAT on the fatigue properties of castings has mainly focused on parts manufactured by the high-pressure diecasting process. This process accounts for the majority of light-alloy parts that are manufactured, especially for automotive applications. However it is generally perceived to create parts with lower reliability than other casting processes and so has limited use in the production of safety-critical components.

A novel heat-treatment process for die castings is being developed in the Light Metals Flagship. Work at QCAT and Clayton (Victoria) is showing that it can deliver improvements in strength, ductility and fatigue life. The process can be adapted in a number of ways to focus the improvements on the most desirable properties for a given application. The process is being trialled on current parts from manufacturers and on prototype parts for new applications that will deliver significant cost savings if they meet the desired properties.

Magnesium Alloy Development

Magnesium, alloyed with a few per cent of rare-earth (lanthanide) elements, has proven to give light castings with excellent properties at the typical temperatures found in car engines. However, these additions are expensive and there is a strong drive to reduce the cost of these alloys without sacrificing the properties. CSIRO researchers elsewhere in Australia have been fine-tuning the composition for optimum cost–benefit, and the QCAT team has developed the production process for this alloy with a 30 per cent cost reduction below the starting benchmark.

Recycling of scrap from these types of materials is difficult and can require scrap to be processed overseas. To complete the technology package for the new alloys, QCAT researchers have developed a flux material that for the first time permits flux-based recycling of these alloys in a way that effectively retains the valuable addition elements. This will open the way for the recycling of scrap at the foundry.

Automation

Autonomous Hot Metal Carrier

The Autonomous Hot Metal Carrier project is part of CSIRO's Light Metals Flagship program. Hot metal carriers (HMCs) are large forklift vehicles used to transport molten aluminium in large metal bucket-like containers called crucibles, from a smelter's potting line to the casting house. They operate 24 hours a day, seven days a week.

At the end of 2004 the Autonomous Systems Laboratory at QCAT was supplied with a HMC for research into automating its processes. The vehicle was configured for automation and the Laboratory team has added scanning laser rangefinders and a vision system for environment sensing. During 2005–06, the project achieved a milestone in long duration operations.

The main objective of the HMC project is to develop technologies that will allow a fully autonomous vehicle to conduct continuous, safe, dependable operations around a worksite containing humans and vehicles. The team has developed algorithms for localisation, navigation and crucible manipulation, and in February 2006 successfully demonstrated the integrated systems in operation. In May 2006, the durability of the HMC and automated systems was tested over five hours of continuous operation. The aim was to show reliable, predictable and consistent performance in navigation and repeated pick-ups and drop-offs of the crucible from different locations around the confined test area. The demonstration was successful, with the HMC conducting approximately 30 rounds of the 300 m test circuit. In that time, it performed around 120 crucible pick-up and drop-off operations and travelled approximately 9 km, with a maximum deviation in navigation path of only 0.3 m.

This is a significant achievement towards automating ground vehicles in industrial sites that require continuous, safe, predictable and efficient performance. The next objective of the HMC project is safe operations in the presence of other vehicles and people around the work site.

Energy

Queensland has coal reserves of more than 30 billion tonnes, enough for several hundred years. This wonderful resource can provide energy in many forms for centuries, if the industry can adapt to the changing needs and demands of a changing society.

Research into coal utilisation at QCAT includes assessing the gasification performance of coal. The ultimate goal is to improve power generation efficiencies, reduce emissions and provide research support for the development and implementation of advanced low emissions power generation technologies in Australia.

Coal utilisation

Demand for electricity in Australia is growing strongly and is predicted to double by 2020. Similarly, demand for Australian coal in world markets is also at unprecedented high levels. As world energy demands increase, there is a growing need to improve the environmental performance of coal-based energy systems. It is therefore very important to improve the performance of Australian power generation technologies and to support the efficient and clean use of Australian coal in domestic and international energy markets.

Research at QCAT encompasses the key stages of coal preparation and utilisation, coal gasification and the development of new 'low emissions' power generation systems.

Coal Gasification

In collaboration with the Cooperative Research Centre for Coal in Sustainable Development, CSIRO operates an advanced coal gasification facility at QCAT. The facility is used to evaluate the performance of Australian coals under the high temperature, high pressure gasification conditions that are central to the leading advanced power generation processes.

Our research provides practical information to assess and optimise coal use in the 'clean energy technologies' that will form the basis of future coal-based power generation systems, capable of operating with low, and ultimately zero, atmospheric emissions. It provides the detailed technical information that is required to introduce and support coal use in new domestic and international markets based on high efficiency coal utilisation technologies. This research will also provide important technical support to assist the domestic power industries assess and implement these technologies in Australia.

Our work is helping the Australian electricity industry reduce the risks of selecting and implementing advanced power generation technologies. It will contribute to the expertise required to evaluate fuel and energy strategies for sustainable energy conversion technologies in this country.

Syngas Processing and Gas Separation Technologies

CSIRO is the major research contributor to the Centre for Low Emission Technology. The Centre focuses on the important gas cleaning, processing and separation technologies that will be necessary enabling technologies for the development of commercially feasible, coal gasification based power systems that incorporate large scale CO_2 capture and hydrogen production.

During 2005–06 this program has established new facilities and capabilities for the development and assessment of novel catalytic gas processing and membrane separation systems. These will be key components in the future development of large scale, low cost, coal-based hydrogen energy systems.

This world-class facility and research program is an important part of a broader national effort to address long-term efficiency and emissions goals for the coal, power and energy industries.

Information and Communication Technology

The applications for new technologies developed through ICT research are limited only by the bounds of our imaginations. The ICT Centre at QCAT is investigating new technology applications in wireless sensor networks, autonomous underwater vehicles, and aerial robotics.

Australian GNSS Joint Undertaking

CSIRO scientists at QCAT are part of a team working to secure North Queensland as the first site for an Australian ground station to service Europe's new satellite navigation system known as Galileo. CSIRO is in partnership with Queensland's Department of Natural Resources, Mines and Water and the Queensland University of Technology under the name of the Australian GNSS Joint Undertaking, which has been invited by the European Space Agency to tender to host the Galileo Sensor Station on Australian soil. If successful this would be the first Galileo Sensor Station in Australia. The invitation followed an initial proposal by the research partners in 2006, and opened the door for the team to take the lead Australian role in Galileo activities.

Galileo is a civilian global navigation satellite system (GNSS) set to rival the availability, accuracy and reliability of the US military operated Global Positioning System (GPS). The Galileo Sensor Station, as it is officially known, will be made up of a number of antennas, receivers, an atomic clock and software to

process the data. It will be connected to a global real-time network. The ground infrastructure for Galileo would initially comprise 15 stations, and would increase to 40 stations by 2010.

One of the substantial benefits of Galileo for Australia results from the joint use of Galileo and GPS. Signals from about 50 satellites would be available for improved navigation and traffic management in pits at mine sites and high rise cities. It is expected that the European Space Agency will make its decision of the location of the ground station by early 2007.

Wireless Sensor Networks

CSIRO has successfully developed the longest running, autonomously operating wireless sensor network in Australia. The network, deployed around the grounds of QCAT, reached its first anniversary of continual operation earlier this year. Wireless sensor networks are a rapidly growing area of research, enabling the measurement of environmental variables at much higher spatial and temporal resolutions than ever before possible.

The QCAT network measures environmental variables such as temperature, soil moisture, water quality, humidity and solar energy levels. Charged by solar panels, these sensor nodes then send the collected data back to a central database to be recorded and analysed.

The network nodes, called Flecks, were developed by the CSIRO ICT Centre and are low cost, low power devices suitable for deployment in large numbers in remote wireless networks. In comparison with other systems, Flecks are extremely robust in a variety of harsh environments, as well as being easy to produce, cost effective and easily modified to measure almost any variable.

Each individual Fleck works independently of the group to record environmental conditions, then cooperates with neighbouring Flecks to wirelessly transfer its data back to a database via an ad hoc network formed from the collection of nodes. Ongoing work seeks to solve the issues associated with programming and deploying much larger wireless sensor networks in harsh and challenging environments.

Aerial Robotics

The ICT Centre's Autonomous Systems Lab has been pioneering research in the area of vision-based flying robots since 1999. The aim of this work is to develop a hovering robot that can be used to inspect infrastructure such as bridges, cooling towers, powerlines and pipelines. In 2002, the group demonstrated an autonomous helicopter capable of estimating its speed and height above the ground using a robotic vision system – which allows the vehicle to observe the world and then use that information to effectively control itself. In May 2003, the project team successfully demonstrated stereo vision-based hovering for over 5 minutes on a small 3Kg payload helicopter. The group is currently developing an autonomous flight capability for a larger (15Kg payload) turbine powered helicopter.

In July 2005, following a joint CSIRO–Queensland University of Technology submission to the Smart State Research Facility Fund, Queensland Premier Peter Beattie announced a $3.53 million funding package to help in the creation of a $12 million Australian Research Centre for Aerospace Automation – Australia's first high-tech autonomous flight research facility. The facility is to be located at the Da Vinci Centre at Brisbane International Airport. The aim of the new centre will be to develop civilian applications for unmanned aerial vehicles — the fastest growing segment of the international aerospace industry.

Autonomous Underwater Vehicle

Autonomous underwater vehicles (AUVs) will greatly improve environmental monitoring and offshore industry operations through unaided task execution in environments and conditions too costly and dangerous to be conducted by humans.

The Autonomous Systems Laboratory at the ICT Centre has been developing a revolutionary low cost AUV called Starbug, which uses advanced vision-based navigation techniques for robust localisation and control.

In 2005, the Starbug AUV underwent extensive trials at Heron Island on the Great Barrier Reef. Autonomous vision-based transects and terrain-following tasks were demonstrated. In June 2006, members of the Starbug project team were invited to Moorea to conduct cooperative research activities in advanced autonomous underwater navigation using underwater sensor networks with MIT and the University of California Berkeley.

This project has received considerable attention from industry and the media in the form of commercialisation opportunities and television appearances with ABC Asia Pacific, Channel Ten's Scope and the Discovery Channel. In the coming year, the Starbug AUV will be used extensively in two CSIRO Wealth from Oceans Flagship projects for environmental monitoring and algorithm development for sub-sea pipeline monitoring and inspection.

Sustainability

The Australian minerals industry is crucial to the country's economic and social wellbeing. Without a viable minerals industry we cannot maintain the social, financial and environmental processes that underpin sustainable development.

The industry's long-term future rests not only on how it responds to economic challenges, but also how it responds to the challenges of sustainable development. Research at QCAT provides the industry with strategies and technologies for developing sound sustainability practices.

QCAT researchers are also involved in investigating sustainability issues in Australian cities, focusing on the energy, water and environmental impacts of our buildings

Mine Environment and Society

Mine Environment and Society is involved in research that assists mineral and energy companies in maintaining their licence to operate. Key issues involve safety, health, environmental management and social integration.

Greenhouse gas mitigation

Greenhouse emissions from mines are the target of a number of research projects aimed at either utilising or collecting the methane from coal mine ventilation air. A technology being developed for concentrating methane from dilute streams also has application to removal of carbon dioxide from power station flue gas. The aim is to develop technologies that can significantly improve the efficiency of greenhouse gas mitigation at mine sites.

Underground Coal Gasification (UCG)

A joint venture company, Carbon Energy, will be launched to commercialise the research performed at QCAT over the last eight years. The initial focus of Carbon Energy is a demonstration of low emission electricity production from underground coal gasification in Australia using advanced low environmental impact techniques with a later expansion to cogeneration of electricity with chemical synthesis.

Diesel particulate reduction

Research is under way on a system to improve the removal rates of very small particulates from the exhaust of diesel mine vehicles, thereby improving air quality in underground mines.

Mine water management

Research is continuing into the application of technologies for waste water treatment and process arrangements that reduce the risk of contaminated mine waters entering the environment.

Acceptability of new technologies

SSocial acceptability is an important factor in the successful uptake of new technologies in the minerals and energy sector. A number of research projects are under way concerned with examining the issues of ocean floor mining, clean coal technologies, future energy production scenarios and intelligent distributed grid power systems. These projects involve combinations of activities including examination of public attitudes, engagement with industry stakeholders and reviewing the impact of information provision on opinions.

Environment, Water and Energy of Cities

The Asset Performance and Sustainability team is active in sustainable cities with focus on lifecycle assessment of the energy, water, and environment impact of buildings and cities. Our partners include the CRC for Construction Innovation (based at the Queensland University of Technology) and the Desert Knowledge CRC based in Alice Springs, Forest and Wood Products Research and Development Corporation and the Queensland Department of Housing.

The CRC for Construction Innovation researches innovation processes and investigates the alignment of regulations across governmental borders. The recently expanded sustainable subdivisions project to investigate ventilation issues in South East Queensland is progressing on target.

The group has been working with the Queensland Department of Housing and the CRC for Desert Knowledge to deliver decision support tools for residential property managers leading to better utilisation of scarce resources.

The Technology Transfer Centre

QCAT acts as a focus for interaction between researchers and industry, and has a strong commitment to furthering technology transfer in the resources industries. The co-location and support of commercial enterprises and other research and development organisations at QCAT's Technology Transfer Centre provides an environment where the exchange of insight, information and technology can thrive.

Almost all of QCAT's commercial tenants occupy the Technology Transfer Centre. They have been attracted by the growing research activity and the creation of a critical mass of mining expertise in an attractive, leafy environment.

Advanced Mining Technologies

Advanced Mining Technologies continues to make considerable headway with its CAS-CAM/RF® collision avoidance technology. A full mine install is under way at the Anglo/Falconbridge-owned Collahuasi mine in northern Chile, while evaluation continues at other mine sites in Australia and the USA. Further success is expected which will generate significant revenues from this development and maintain CAS-CAM/RF® technology as the market leader, as well as underpin ongoing development.

The company's Drill Guidance System provides the underground coal industry and surface coal bed methane operators with a state of the art electronic measurement while drilling steering tool for gas drainage. The System is available in both intrinsic safe configuration for underground operations and non-intrinsic safe configuration for surface to seam operation. The System has set a new benchmark for directional drilling technologies with ongoing sales success in Australia, the USA and China.

During the 2005–06 year the company centralised its operations, and can now be reached through its Sydney office on +61 2 4389 2344.

Alcan Queensland R&D Centre

As part of a long-term commitment to bauxite mining and alumina production in Australia, Alcan relocated a significant part of its bauxite and alumina research and development efforts to Australia in 2002. The Alcan Queensland R&D Centre (QRDC) is now located on the QCAT campus.

Building 'Y' on the QCAT site was completed in April 2005. After taking up occupancy in May, and an official opening in July 2005, QRDC has settled into the new facility and has been steadily expanding its staff and developing its R&D program.

The building was nominated for a number of architecture awards, and QRDC occupants are very happy with the functionality and comfort of the facility. Alcan QRDC was recently recertified for ISO 14001 and 18001 after extensive review and rework of environmental health and safety policies and procedures to account for the relocation to Building Y.

The new laboratory is developing world class Bayer (alumina refining) R&D capability, and has begun setting Brisbane (and the QCAT campus) on the world stage in the alumina industry. In February 2006, QRDC's Manager (Mr Steven Healy) was appointed to the role of Global R&D Director for Alcan's Bauxite and Alumina business group, further making QRDC an important site in Alcan, and QCAT a significant site for the alumina industry.

The QRDC supports Alcan's Australian assets including the Gove bauxite mine and alumina refinery in the Northern Territory (100 per cent ownership), Queensland Alumina Limited, Gladstone, Queensland (41.4 per cent ownership), and the Tomago Aluminium smelter in NSW (51.55 per cent ownership).

Much of the effort at QRDC in the last year has supported the 1.8 million tonne, $2.4 billion Gove Expansion in the Northern Territory. Technical assistance to other Alcan operations, to technology sales customers, and strategic research and development projects made up the balance of activities.

Alcan continued in the last year to expand its collaborations with Australian Research organisations. Alcan's commitment to the seven year Parker Centre III CRC was formalised, and QRDC's Manager was appointed to the board of the new Centre. Alcan supported a number of collaborative research initiatives involving CSIRO or CRCs with CSIRO participation, including AMIRA projects P266E, P507B, P521B, P931, P791, P942, P943. Other projects are being developed and initiation of a number of these is expected in the coming year.

Alcan Inc. is a leading global materials company with world-class technology and operations in bauxite mining, alumina processing, primary metal smelting, power generation, aluminium fabrication, engineered solutions as well as flexible and speciality packaging. Alcan is represented by 65,000 employees in 61 countries and regions, and in 2005 posted revenues of US$ 20.3 billion. The Company has featured on the Dow Jones Sustainability World Index consecutively since 2003.

Applied Mining Technologies Pty Ltd

Applied Mining Technologies plays a key role in the successful transfer of mining guidance technologies from research to a commercial, industry-accepted solution for highwall mining applications. Machine guidance is considered essential for safe and productive highwall mining.

Equipment manufacturers have incorporated AMT technology into new and existing production systems. This has resulted in significant improvements in production rates and resource recovery, and has provided the enabling technology for ongoing advances in automation. In collaboration with major equipment manufacturers and suppliers, AMT has developed a complete and integrated highwall monitoring and control package incorporating inertial and horizon control technologies.

Australian Centre for Minerals Extension and Research (ACMER)

ACMER pursues its mission of providing the scientific and technological rigour and support to enable the minerals industry to plan, operate and close mines in an environmentally and socially responsible manner through research, technology transfer and advisory services.

Major research programs include waste rock dump stability, final void use, prevention and remediation of acid mine drainage, mine water management, tailings disposal and remediation, and ecosystem reconstruction.

In 2005–06, ACMER started three new research projects:

- Validation of a risk assessment model for tunnel erosion on waste dumps
- Designing effective store-release covers for the long-term containment of mine waste – The role of vegetation (Stage 2)
- Standard protocols for the long-term prediction and monitoring of mine lake water quality.

This year, as part of an Australia-wide technology transfer program, ACMER conducted three short courses and ten workshops on environmental and social issues relevant to the minerals industry.

Centre for Low Emission Technology

The Centre for Low Emission Technology (cLET) continues its R&D into ways of using Australia's coal resources to produce zero carbon electricity and hydrogen, to allow a smoother transition between the current energy infrastructure and a zero emission energy infrastructure of the future.

During 2005–06 the unincorporated joint venture was amended to include partners Australian Coal Research Limited, Stanwell Corporation Limited, Tarong Energy Corporation Limited and The University of Queensland. They join the Queensland Government (through the Department of State Development, Trade and Innovation) and CSIRO (through CSIRO Energy Technology and its Energy Transformed Flagship Program) in the quest to develop enabling technologies for the production of low emission electricity and hydrogen from coal.

cLET's research focus continues to be in the areas of gasification, gas cleaning, processing and separation. Projects being undertaken in this area by the centre's researchers are:

GCF001 Pilot plant tests on Australian coals

- In conjunction with the Cooperative Research Centre for Coal in Sustainable Development (CCSD), cLET are developing a project to test the performance of up to three Australian coals in a pilot scale gasifier.

GCF002 National low emissions gasification test facility

- Proposal to build a 5 MWt pilot scale gasifier in Australia for comprehensive testing of coal performance; assisting gasifier and gas cleaning technology selection; supporting a gasifier demonstration plant; testing scale-up of gas processing concepts; and potential to test fuel cells, hydrogen combustion and storage, biomass co-utilisation and coal to liquids technology.

GCF003 Syngas generator

- Building a plant for proving gas processing concepts with a realistic coal derived syngas.

GC001 Dry gas cleaning

- Filtering gas to protect downstream process units with less water consumption and loss of power.

GP001 Water gas shift catalysts

- Test performance of shift catalysts and develop their tolerance to coal-derived syngas.

GP002 High temperature catalytic membrane

- Combination of shift and separation processes to lower costs.

GS001 Molecular sieve silica membrane systems

- Lower cost ceramic separator for hydrogen from shifted syngas.

GS002 Metal membranes for hydrogen separation

- Thinner, cheaper metallic separator for hydrogen from shifted syngas.

cLET has also undertaken research to determine public perceptions and knowledge of clean power through its social and economic integration project:

SEI001 Assessing and integrating stakeholder perspectives

cLET is a member of the Coal21 forum and the IEA Greenhouse Gas R&D Programme, which the cLET CEO, Dr Thambimuthu continues to chair. Dr Thambimuthu also continues his work on the United Nations Intergovernmental Panel on Climate Change (IPCC) and is a technical advisor on the United States led initiative to construct the coal-based FUTUREGEN power plant.

Cheron Group

Cheron is Australia's newest and most progressive innovation incubator. It proposes to fund, develop and commercialise a portfolio of early stage technologies in the area of highly advanced, energy and emission solutions.

Cheron's objective is to exploit technical and commercial opportunities that arise in this rapidly evolving global industry, particularly in a market that faces the challenges of increasing competition, demanding customers, rising concerns about availability and fuel costs, and the ever increasing demands of environmental impacts globally.

Increasing demand for fully developed, field tested 'next generation technologies' is a key part of the industry's response.

The Cheron Group's 'fully integrated, holistic approach' is unique. It entails active technology sourcing, rigorous screening and assessment, provision of the right amount of funding at the right time, application of critical skills as and when required, and a fully hands on control of the development and commercialisation process.

Cheron is proposing to raise $100 million (AU) through its new Australian 'Early Stage, Venture Capital Limited Partnership Fund', starting in November–December 2006, which will fund a portfolio of technologies and the development of the group over the next five years.

Coal Augering Services

Coal Augering Services was established in 2003 and is based at QCAT with operations in Queensland and New South Wales. Auger mining is employed to increase reserves by accessing coal lying beyond the economic reach of conventional stripping operations. Coal Augering Services offers a turnkey, high productivity contract auger mining service, enabling safe and economic access to reserves that are otherwise inaccessible. They are able to undertake all works from pit cleanup through to product haulage to run of mine unwashed coal.

Coal Augering Services new generation of coal recovery augers is capable of drilling holes with diameters of 1.2–1.9 m, to a depth of more than 200 m and augering up to 2,400 t in a 12 hour operating shift. To date, Coal Augering Services has achieved a number of Australian production records for surface auger mining, which include:

- auger hole depth of 203 m (single auger)
- production of 2,437 t in a single shift
- production of 10,000 t in a 5 shift week.

In March 2006 Coal Augering Services completed a project with Fassifern Auger Mine operations. Centennial Coal and Coal Augering Services identified potential contour benching and auger mining reserves at Newstan Colliery in the Great Northern Seam. The aim of the Fassifern Auger Mine was to recover reserves between outcrop and old underground workings in advance of the Southern Reject Emplacement Project. This was the last chance to access these reserves before the area was covered with washery reject material. The project recovered 444,000 t over 18 months.

ComEnergy Pty Ltd

ComEnergy Pty Ltd, a CSIRO and industry partnership company, was established in 2003 to commercialise the hybrid coal and gas turbine (HCGT) system patented by CSIRO.

The HCGT burns gas, waste coal or biomass in a rotating kiln to produce hot exhaust gases which in turn pass through a specially adapted heat exchanger to produce steam, which spins the turbine to produce electricity. The HCGT can use low quality energy sources, high sulphur and high ash content coal, tailings, lignite, biomass or municipal waste as its fuel, to generate power, turning what is currently regarded as waste into electricity.

HCGT technology will significantly reduce the environmental impacts of coal mining by lowering fugitive methane emissions from underground mines, reducing acid runoff and gaseous emissions from waste coal stockpiles. At the same time it will deliver potentially significant savings on power and waste coal management costs. An outstanding asset of the HCGT is its ability to convert coal mine methane into carbon dioxide and earn greenhouse gas abatement credits, an additional income resource.

The US and Australian Federal Governments have signed a Climate Action Partnership agreement with 18 countries including China. Under this agreement, HCGT technology is one of seven technologies that the partnership will promote to ensure rapid uptake.

ComEnergy Pty Ltd has assigned marketing rights to renewable energy and water purification specialist EESTech Inc. EESTech Inc. is a network member of the Methane to Market initiative: a US Environmental Protection Agency sponsored organisation. EESTech intends to establish a 30 MW HCGT power plant in Fuxin City, Liaoning Province, China.

Cooperative Research Centre for Coal in Sustainable Development (CCSD)

CCSD brings together most of Australia's coal research skill base as well as experts in sustainability who are recognised internationally as being at the forefront of coal research in the international science community. Government and industry have committed $63 million over the seven year period 2000–2008 to identify and investigate opportunities for coal chain efficiencies and reducing carbon intensity in energy systems, by providing a better understanding of Australian coal performance in combustion, gasification and emerging sustainable coal utilisation technologies. Other research areas include environmental and social assessment, iron making, and by-product and waste utilisation.

The Centre's 19 participants from industry, government departments, CSIRO and universities provide strong support through their participation in all aspects of the Centre's R&D activities. The Centre's education program supports some 40 PhD students in the research programs as well as industry education seminars and workshops.

In 2005–06, climate change and sustainable development continued to provide the focus for international action related to greenhouse gas emissions. Major initiatives such as the Australia Pacific Partnership for the collaborative demonstration and deployment of low emission technologies; the first round of funding under the Australian Government's $500 million Low Emission Technology Development Fund; the establishment of the $300 million COAL21 Fund by the coal industry; and the establishment of the Queensland Future Growth Fund in which $300 million is earmarked to support the development of clean coal technology, demonstrate the commitment of government and industry in Australia to action that addresses the greenhouse gas emissions problem faced by the world.

In 2005–06, CCSD researchers have made a significant contribution to the knowledge needed to make informed decisions about the technologies that will need to be deployed for a low emissions future. ACIL Tasman – expert consultants in economic, policy and strategy — established and reported favourably on the value of research undertaken in the Centre. They noted:

that potential improvements in plant availability resulting from CCSD pre-investment research could result in capital cost savings of between $500 million and $1,600 million for the Australian industry.

To maintain momentum and provide expert advice on the research program and technology transfer of emerging low emissions technologies, CCSD hosted several eminent visitors to Australia, who included: Prof Ken Okazaki (Tokyo Institute of Technology, Japan) – advanced energy technologies; Prof Larry Baxter (Brigham Young University, Utah, USA) – biomass; Dale Simbeck (SFA, California USA) – gasification energy technologies; Dr Jacek Podkanski and Dr Dolf Gielen (IEA, Paris, France) – modelling energy technologies; Dr Lesley Sloss (IEA Clean Coal Centre, London, UK),– emissions from coal fired power generation; and Dr Stu Dalton (EPRI, San Francisco, USA). The visitors participated in well-attended and useful seminars/meetings with industry and researchers.

In late 2005 the Australian Government's Low Emissions Technology Development Fund called for applications for the funding of large technology demonstration projects. CCSD is a supporting collaborator for the Oxy-fuel Demonstration Project at Callide A Power Station submitted to the Fund by the Australian–Japanese consortium led by CS Energy. The demonstration project builds on the outcomes of the CCSD project which developed a reference design for the retrofit of an existing coal fired power station (Callide A). CCSD has also supported other demonstration applications, such as the Stanwell ZeroGen Project — a demonstration gasification combined cycle power generation plant with carbon capture and geological storage — by the provision of technical information.

During 2005–06 there were 11 postgraduate students undertaking PhD training in CCSD.

GeoTek Solutions

GeoTek Solutions is a geotechnical consultancy specialising in slope stability for open cut mines. Since 1999 the company has operated from the Technology Transfer Centre.

Reflecting the buoyant domestic mining conditions, GeoTek Solutions has operated mostly in the Bowen Basin during the past year. To help with the increased workload, geology students from UQ have been employed. This has provided them with an opportunity to do hands-on engineering geology work for the mining industry.

Strong links have been maintained with CSIRO Exploration and Mining through the SiroJoint technology. Paul Maconochie of GeoTek Solutions was a co-author of a paper on the design and construction of the Crinum East highwall mining trench for which data from SiroJoint was used. The paper was

presented at the 2005 Bowen Basin Symposium which was attended by over 300 delegates. He also helped CSIRO present a SiroJoint workshop at the same symposium.

GeoTek Solutions is a participant in a current ACARP project headed by Sherwood Geotechnical and Research Services that will also involve CSIRO.

The Technology Transfer Centre has facilitated linkages with another occupant, Coal Augering Services, and it is expected that similar opportunities will continue to arise.

These interactions continue to demonstrate the value of the QCAT location in facilitating research–industry interaction for a micro-enterprise working in the Australian mining industry.

Instinct Television

Instinct Television is an independent television production company creating quality documentaries for the Australian and international television market.

Instinct Television this year provided foreign language services to fellow CSIRO client Advanced Mining Technologies, producing Spanish and Chinese language versions of its promotional DVD. The company also produced a continuous play DVD for CSIRO Exploration and Mining for display at AESC 2006.

The company this year completed a series of educational videos for the Qld Cancer Fund. The three titles, Understanding Chemotherapy, Understanding Gynaecological Cancer and Understanding Prostate Cancer are a series of patient care DVDs providing information to patients and family from the point of diagnoses, during treatment and through to recovery.

A television documentary and DVD series titled ‘Ruff, Tuff and Real’ produced with former Australian heavy weight wrestling champion, Ron Miller, explores the story of World Championship Wrestling in Australia from the 1960s to the late 1970s. The documentary features interviews and matches with many Australian and international legends of the sport and will screen on Australian television, along with a three pack DVD available from retail outlets throughout Australia and NZ.

Instinct Television continues to provide interactive video content for Sydney based marketing company Yeah Point. The interactive display screens offer consumers a range of product and price information at point of sale.

The company is currently exploring video delivery methods for a large screen display system currently in development.

Jenkins-Kwan Technology Pty Ltd

Jenkins-Kwan Technology is involved in a broad range of R&D projects. Projects at QCAT since 2000 have focused on the development and commercialisation of automated instrumentation for the coal mining industry and coal users.

With the assistance of ACARP grants we have developed several unique new methods for analysing coal and its constituents as part of a coal petrography automation project. The main applications include characterisation of (i) raw thermal and coking coals, (ii) preparation plant feed, product and tailings samples produced in plant optimisation studies, and (iii) monitoring and ‘fingerprinting’ of shipment blends.

These capabilities have been incorporated in the MACE®300 coal petrography system, which analyses the organic constituents (macerals) of coal particles by light microscopy and image analysis. The output of the system is also being integrated with that of a complementary instrument — the mineral liberation analyser. The analyser was developed by the Julius Kruttschnitt Mineral Research Centre and is the world’s leading and top selling electron microscopy system for imaging mineral particles. The combination of the output of the two systems produces a new picture of coal that was not accessible previously and can provide vast quantities of new data for coal technologists involved in understanding and optimising coal processing and utilisation.

The R&D phase of the coal petrography automation project is nearing completion. Commercialisation will be undertaken by OPTICOAL Pty Ltd, a start-up company that can be contacted at PO Box 1805, Milton B.C., Queensland 4064.

LAADtech

LAADtech started operation at the Technology Transfer Centre in November 2005, and is currently in the R&D stage, investigating new large area screen display systems. It also works in conjunction with Instinct Television in developing video content delivery systems.

The Benefits of QCAT

The Argyle report

In November 2005 Argyle Corporate Advisors conducted an independent review of QCAT's operational status. The review found that QCAT is the principal single centre in Australia for R&D for the resources industries, and is a world leader in its field.

QCAT was identified by the mining industry and those associated with it, including CRCs, government and other industry participants, as a provider of outstanding and very innovative research. The report highlighted a number of highly significant areas in which QCAT research is actively creating long-term benefits for the industry. These areas included: longwall automation; gas drainage; highwall mining; coal preparation; ROES™, a non entry remote controlled method of hard rock mining; light metals engineering; mineral processing; coal utilisation in clean coal technology.

QCAT has attracted considerable investment in Queensland based R&D. As part of a collaboration with CSIRO, the Queensland government made an initial investment in QCAT of $44.3 million; $9 million as a grant and $35.3 million repayable at favourable terms. The review noted from 1992–03 to 2004–05 QCAT has incurred $313 million in research expenditure. Of this, 51.5 per cent has been funded from CSIRO appropriation funds with the balance of the investment coming from external sources, including industry, CRCs, government and international agencies.

The report also commented on QCAT's considerable success in forming both national and international alliances. The concentration of mining and minerals expertise at the QCAT site continues to attract international attention. A notable example is Alcan's Pacific area alumina research, which was moved to the QCAT site from the UK. In the past year QCAT has hosted representatives and delegations from government departments, research organisation and industry from Chile, China, Thailand, Japan, South Africa, Mexico, Germany, America, the UK, India and France.

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Your CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.

CSIRO's diverse capabilities at QCAT include mining geoscience, coal and metalliferous mining, geotechnical support, iron ore and non-ferrous mineral processing, light metals engineering, coal utilisation, sustainability and ICT.

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