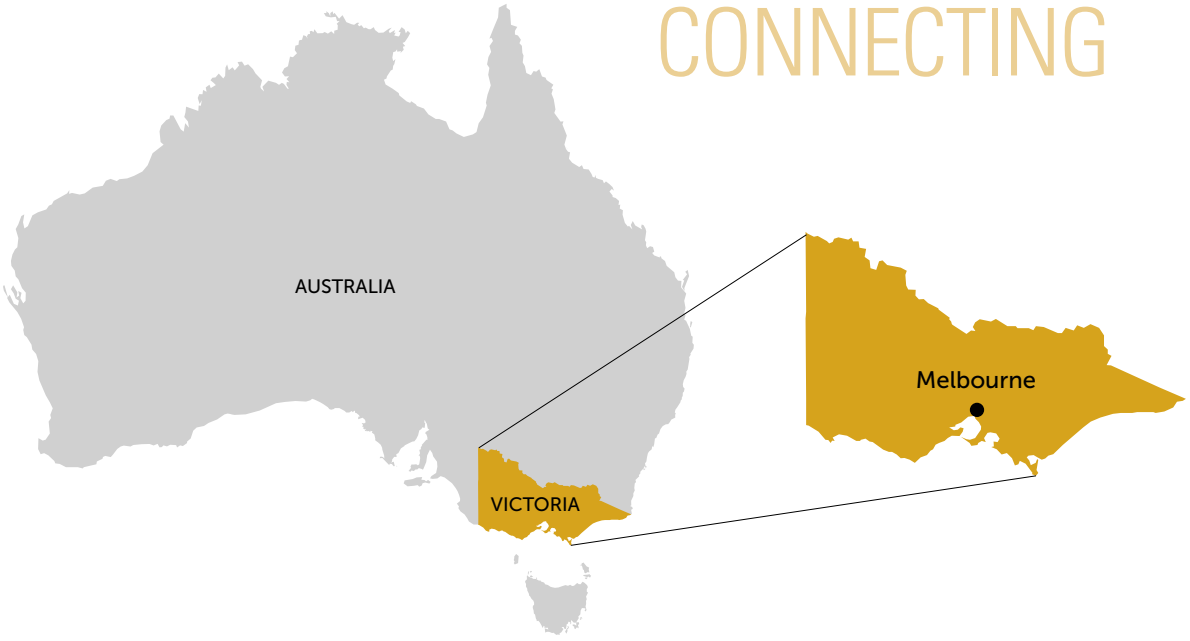
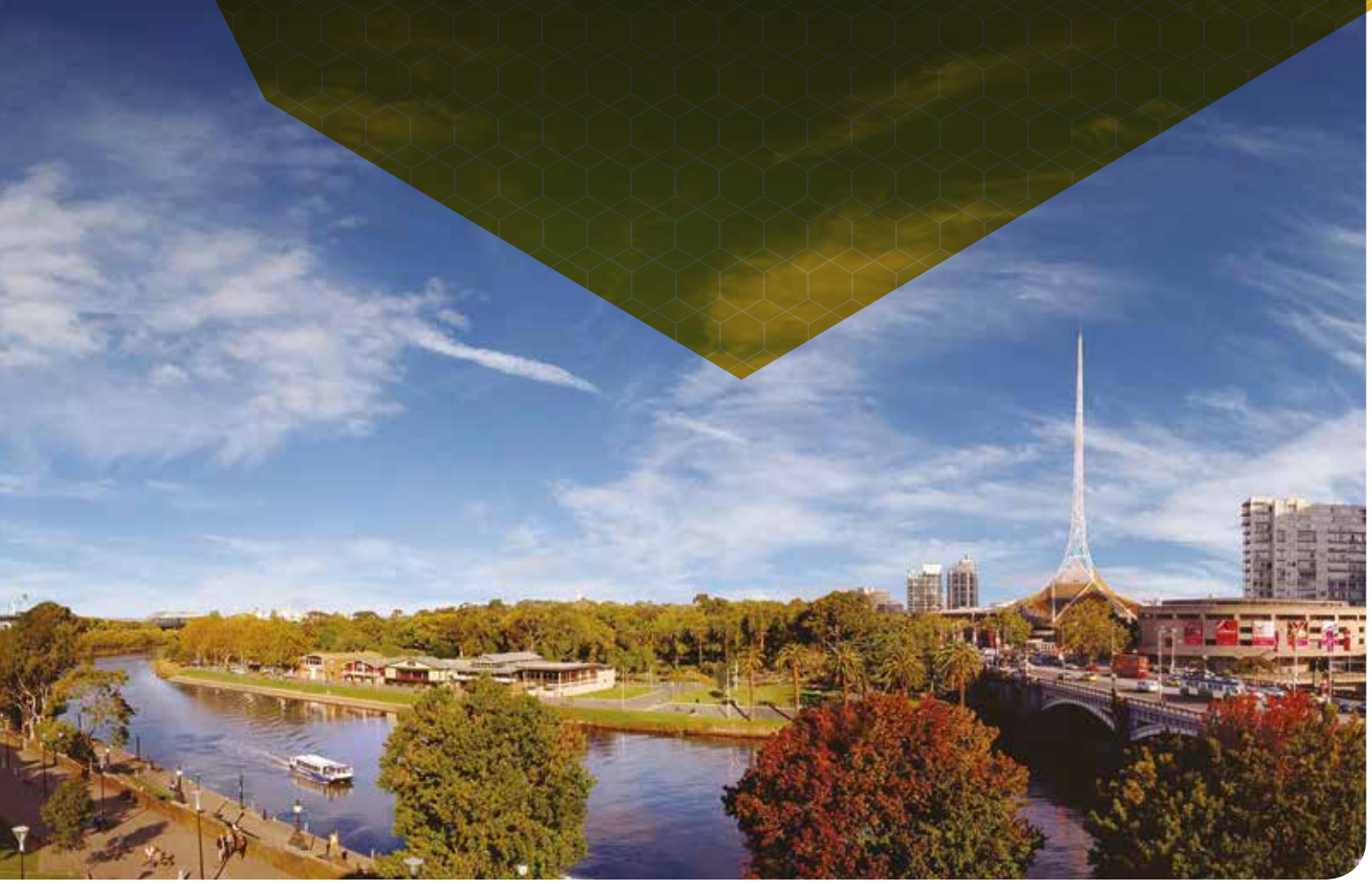
MELBOURNE
RESEARCH, EDUCATION AND TRAINING

MINING

MELBOURNE
VICTORIA AUSTRALIA

MELBOURNE:
LEADING
INNOVATING
CONNECTING





Melbourne and regional Victoria are a perfect blend of economic strength and dynamism, with a lifestyle that is envied around the world. Talented people, a world-class education system, supportive government and superior infrastructure make the state of Victoria a global leader in research, education and vocational training.

Victoria's research centres, universities and vocational training providers partner with industry, governments, non-government organisations (NGOs) and other educational institutions around the world.

They offer extensive opportunities for partnerships and program collaborations, including joint research initiatives, research and development services, licensing of materials, tailored curriculum development, joint program delivery, staff/student exchange, consultancy services and customised employee development programs.

For more information about Victoria's research, higher education and vocational training capabilities, contact your region's Victorian Government Business Office at: **invest.vic.gov.au/offices**.

THE MINING AND RESOURCES INDUSTRY IN MELBOURNE

Victoria's capital, Melbourne, is emerging as an internationally recognised hub for the mining and resources industry.

Victoria is the birthplace of the Australian mining industry. The discovery of gold in Victoria in the 1850s and 60s drove unprecedented growth and laid the foundations for much of the state's growth over the nineteenth and twentieth centuries.

Melbourne consolidated its position as the nation's centre for expertise in product and service solutions for the resources sector as the extent of Australia's mineral wealth was discovered over the following 150 years.

As Australia's longstanding leader in business and finance, manufacturing, research and development (R&D) and cutting-edge technology, Melbourne is a natural home base for national and international mining companies in Australia.

Melbourne serves as a headquarters for seven of the 25 largest Australian Stock Exchange listed mining, metals energy and utilities companies led by BHP Billiton, Rio Tinto and Newcrest Mining. The combined turnover of these companies is A$154 billion.

With Australia now the world's leading producer of gold, lead, nickel, uranium and zinc and second leading producer of iron-ore, bauxite and brown coal, Melbourne has become a globally significant centre of expertise for the mining and resources sector.

Victoria is a global leader in the design, manufacture and delivery of Mining Equipment, Technology and Services (METS). It is also a leader in industry-focused R&D for the mining and resources sector,– in areas including exploration, productivity-enhancing technologies and sustainable development.

MINING EQUIPMENT, TECHNOLOGY AND SERVICES (METS)

METS is one of Australia's largest export sectors and Victoria takes a strong share of the sector's exports with revenues at approximately A$17 billion.

Australia's mining industry operates in some of the most remote and harsh conditions found anywhere in the world. Meeting these challenges has made Victoria a global leader in the delivery of product and service solutions for the Australian and international resources sectors. Victoria's strengths are built on more than 150 years of mining heritage, a highly skilled workforce and Victoria's proven capabilities in:

- Mineral exploration
- Mining products
- Engineering consulting
- Construction
- Information and communication technology
- Financial services
- Professional services including legal services and recruitment.

It is this comprehensive suite of capabilities that defines Melbourne as a global hub for the mining and mining services industry.

A recent study by Austmine, Australia's peak industry body for METS, shows that the Australian METS sector generates A$90 billion in revenue and contributes 6.4 per cent to the Australian economy. The sector is estimated to comprise between 1,200 and 1,500 companies.

INNOVATION IN MINING TECHNOLOGY

Victorian METS companies have continued to make significant investments in R&D. Recent examples of Victoria's METS innovation include:

- Safescape's Laddertube, a strong and lightweight series of ladders which can be easily installed as an escape or secondary route for underground mines
- Gekko Systems Python modular processing plant, which cleanly and efficiently extracts minerals onsite within underground mines using gravity separation and flotation technology
- Trimble Planning Solutions Quantm® software, which finds the best route for major infrastructure projects and has helped mining companies minimise environmental impacts and maintenance costs.

RESEARCH AND DEVELOPMENT

Victoria is a global leader in research for the resources industry, with expertise in areas including:

Mineral exploration: geoscience research in collaboration with the mining industry, advancing knowledge of the physics and chemistry of mineralisation in order to develop better models and tools for predicting where deposits can be found.

Sustainable development: mine waste management, water treatment and management, sustainable chemistry, energy materials, energy systems, renewable energy sources and clean technology.

Productivity-enhancing technologies: predictive maintenance of mining equipment, equipment performance, optimisation and scheduling, big data analytics and robotics.

Enhancing production: mining engineering, extraction and recovery of metals, low carbon emissions technologies, unconventional gas extraction technologies, and value-added high performance metals.

Business operations and people: occupational health and safety, human resource management and workplace relations, workplace productivity, and global business operations.

Regulations and corporate social responsibility: commercial law, corporate social responsibility, native title and human rights, energy law, environmental law and regulation of natural resources.

Victoria's innovation ecosystem encompasses the following world class R&D infrastructure:

- The Commonwealth Scientific and Industrial Research Organisation (CSIRO) – Australia's national science agency, CSIRO's Minerals Down Under Flagship works across the minerals value chain to increase the productivity of the minerals industry and reduce its environmental footprint globally.
- The Australian Synchrotron is the largest stand-alone piece of scientific infrastructure in the Southern Hemisphere and has contributed to the improvement of the alumina production process, amongst other projects.
- The Maintenance Technology Institute, originally established by BHP Billiton and operated by Monash University, has been delivering R&D and consulting services to the mining industry for over 14 years. It is dedicated to improving the performance and reliability of plant equipment through the use of the latest technologies and state-of-the-art analysis techniques. Clients include BHP Billiton, Rio Tinto, Xstrata Coal (Glencore), Anglo Coal, Peabody, Wesfarmers and Caterpillar.
- Monash University's Institute of Railway Technology has been delivering technology-based solutions to the railway industry including heavy haul for over 40 years. The Institute's areas of expertise include track structure design and maintenance, vehicle and track instrumentation, and standards development and personnel training.

In 2014, Melbourne will be home to a globally significant annual mining conference. The inaugural International Mining and Resources Conference (IMARC), to be held at the Melbourne Convention and Exhibition Centre in September, will cement Victoria's reputation as a hub for mining and mining services.

EDUCATION AND TRAINING

Victoria is a world-leading provider of education and training to the mining sector. Its nine publicly funded universities, institutes of technical and further education (TAFE) and high quality private registered training organisations (RTO) provide diverse education programs and the close industry links that are a characteristic strength of Victoria's higher education and vocational education and training systems.

One of a number of Victorian universities providing advanced higher education for the resources sector, Monash University now offers a dedicated Bachelor of Mining Engineering, arising from its partnership with mining companies Newcrest Mining and MMG, to meet future skills demands in the industry.

A number of Victoria's vocational training institutes deliver tailored, accredited workforce training programs on location for mining operations around the world, in areas including operations, safety and people management.

CASE STUDY

OVER THE SEVEN YEARS OF THEIR PARTNERSHIP, **GIPPSTAFE HAS ISSUED OVER 500 QUALIFICATIONS TO OK TEDI MINING EMPLOYEES.**

CLIENT MANAGERS THE KEY TO GIPPSTAFE'S QUALITY TRAINING DELIVERY

GippsTAFE has worked with Ok Tedi Mining in Papua New Guinea over the last seven years to analyse, develop and respond to their training needs in specialist trade areas such as training and assessment, automotive airconditioning, instrumentation, surface extraction, polymer processing and high voltage.

GippsTAFE believes that the key to meeting the training needs of the mining industry in Papua New Guinea has been the combination of specialist training expertise and the appointment of a dedicated Papua New Guinea Country Client Manager.

The Client Manager works in-country for weeks at a time, analysing and determining appropriate training solutions for identified issues in the workforce in partnership with the client.

"Each program is unique: one size does not fit all," says Papua New Guinea Country Client Manager Doug Mullen. "We apply our training knowledge and experience to develop a training solution that achieves the most effective learning and qualification outcomes for the client."

The client-specific training solutions include consideration of the infrastructure and equipment requirements, flexibility in delivery strategies and the employment of key trainers from around Australia.

This access to specialist trainers' expertise is critical to the success of the partnership. The trainers are employed not only for their experience in the trade; they are also passionate about their trade, highly competent in teaching and assessing, and capable of adapting to different environments and reacting quickly to changing circumstances.

The Country Client Manager continues to oversee, monitor and evaluate the training solution ensuring the quality remains at its highest standard.

"Ok Tedi Mining has a strong commitment to their employees to recognise their industry knowledge and skills. Therefore the programs have strong assessment and recognition of prior learning components to meet the client's needs," says Mr Mullen.

Over the seven years of their partnership, GippsTAFE has issued over 500 qualifications to Ok Tedi Mining employees. GippsTAFE also provides training and assessment services to Newcrest Mining and Oil Search in Papua New Guinea, including the delivery of certificate and diploma-level programs.

A GOLDEN OPPORTUNITY FOR MINERAL EXPLORATION

Using the Australian Synchrotron, scientists from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) have found tiny particles of gold in tree leaves that may indicate the location of gold deposits.

The proof that eucalypts can transport gold from deep beneath the ground through their root systems into the leaves is expected to generate great interest from within the gold mining and exploration industry, which spends billions of dollars per year searching for new deposits.

Scientists have found tiny 'nuggets' of gold in leaves taken from eucalyptus and acacia trees located 30 metres above gold deposits. The gold is not visible to the naked eye, but researchers used the Maia detector with the X-ray fluorescence microprobe at the Australian Synchrotron to locate the gold within the leaves. The Synchrotron produced images of the gold, which would otherwise have been untraceable.

Photo: Melvyn Lintern, CSIRO

"Our advanced X-ray elemental imaging enabled the researchers to examine the leaves and produce clear images of the traces of gold and other metals nestled within their structure," Principal Scientist Dr David Paterson said.

"The Maia detector is a fantastic Australian invention. By scanning up to one thousand times faster than any other X-ray microscope in the world, we were able to find these minute gold particles for the first time."

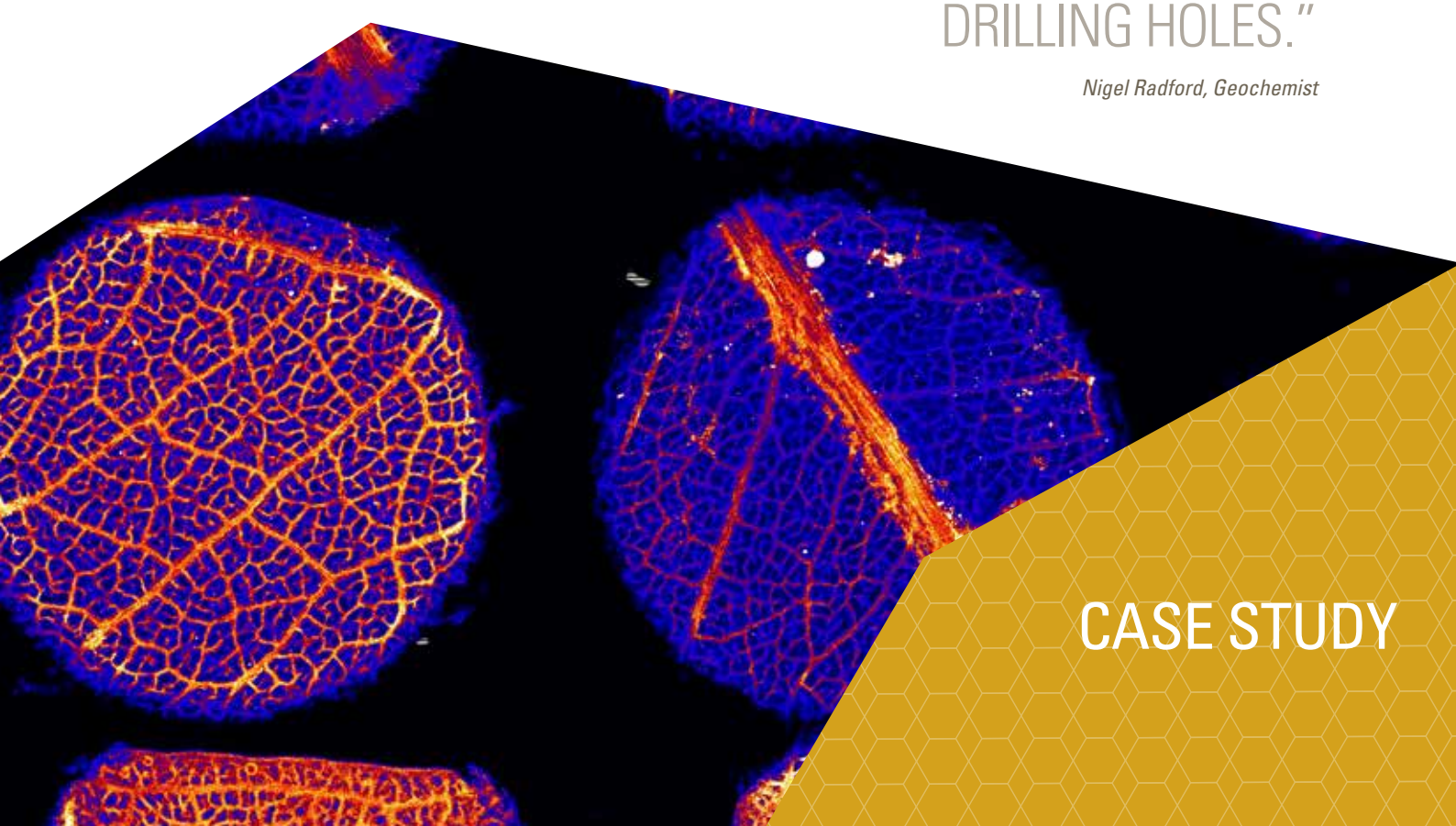
Former Newmont Mining geochemist, Nigel Radford, says the implications for gold exploration are huge.

"A lot of this stuff has been speculated about for some time, but the identification of the gold particles in the leaf materials is completely convincing and very, very important for the future of mineral exploration," said Mr Radford, who has worked in mineral exploration his entire working life, most recently with US-based Newmont, one of the world's biggest gold mining companies.

Mr Radford believes it has the potential to make gold exploration much quicker and cheaper. "Ideally, any mineral exploration team would like to collect their samples on-surface," he said. "If you can sample on-surface, it saves all the cost and all the time involved in drilling holes."

"IF YOU CAN SAMPLE ON-SURFACE, **IT SAVES ALL THE COST AND ALL THE TIME** INVOLVED IN DRILLING HOLES."

Nigel Radford, Geochemist



CASE STUDY

CASE STUDY

AUSTRALIAN RESEARCH LEADS TO MINERAL WASTE MINIMISATION

Fundamental research at University of Melbourne and Monash University on fluids that contain solid particles has enabled the alumina industry worldwide to reduce the volume of waste it produces by about half, while recovering valuable raw materials.

It's all to do with the properties of non-Newtonian fluids – pastes and slurries which show distinctly different flow characteristics from standard liquids. Professor David Boger and his students and colleagues have for many years been at the forefront of studying the mechanics of non-Newtonian fluids, and were able to apply their understanding to the minerals industry.

The result is a technique called dry disposal that, instead of a water-like suspension to be stored in a dam or pond, produces a paste that can be piped to an area for stacking and drying as a solid.

The process minimises the risk of tailing dam failures, of which at least two per year worldwide result in deaths and disastrous environmental problems. It also reduces the volume of waste by one half, recycles water and valuable chemicals and represents a major move towards more sustainable processing.

The dry disposal technology is now slowly being adopted in the copper, oil, sands and coal industries. A company, Rheological Consulting Services, is now providing this waste disposal service to the mining industry internationally.

THE PROCESS MINIMISES THE RISK OF TAILING DAM FAILURES, OF WHICH AT LEAST TWO PER YEAR WORLDWIDE RESULT IN DEATHS AND DISASTROUS ENVIRONMENTAL PROBLEMS.

MAXIMISING DRAGLINE PRODUCTIVITY

Australian and international coal mines have been able to increase the productivity of their draglines, thanks to the expertise provided by Monash University's Maintenance Technology Institute.

Draglines are used primarily in surface mining for the removal of the soil and rock above coal, known as overburden. These huge machines can move over 100 cubic metres of material at a time in their bucket, at a rate of one bucket per minute. This means even minor improvements in dragline productivity can lead to large increases in mine profitability.

The managing director of Monash's Maintenance Technology Institute, Gerard Chitty, said the Institute has completed dragline capacity assessments and production improvements for over 75 draglines.

"We have calculated the safe working capacity at various operations including BMA, Rio Tinto, Anglo Coal, Wesfarmers, Glencore and BHP Billiton Energy Coal South Africa. Following these assessments and implementation of structural upgrades, most draglines are operating at 110 to 125 per cent of the original design rated suspended load within a safe working envelope," he said.

The Maintenance Technology Institute uses high-tech monitoring systems and applies a five-step process to maximise the performance of draglines. The Institute is developing and trialling real-time monitoring systems for other mining equipment such as excavators, shovels, large mining trucks and drills, which are used extensively in mining.

"We are able to remotely monitor in real time and stream data to our Melbourne base from mobile equipment onsite to provide feedback on issues such as damage or poor performance. We are able to identify operators who might need further training and highlight specific areas where improvements are needed," Mr Chitty said.

The Maintenance Technology Institute prides itself on providing comprehensive, independent advice that makes a real positive financial impact on the mining industry.

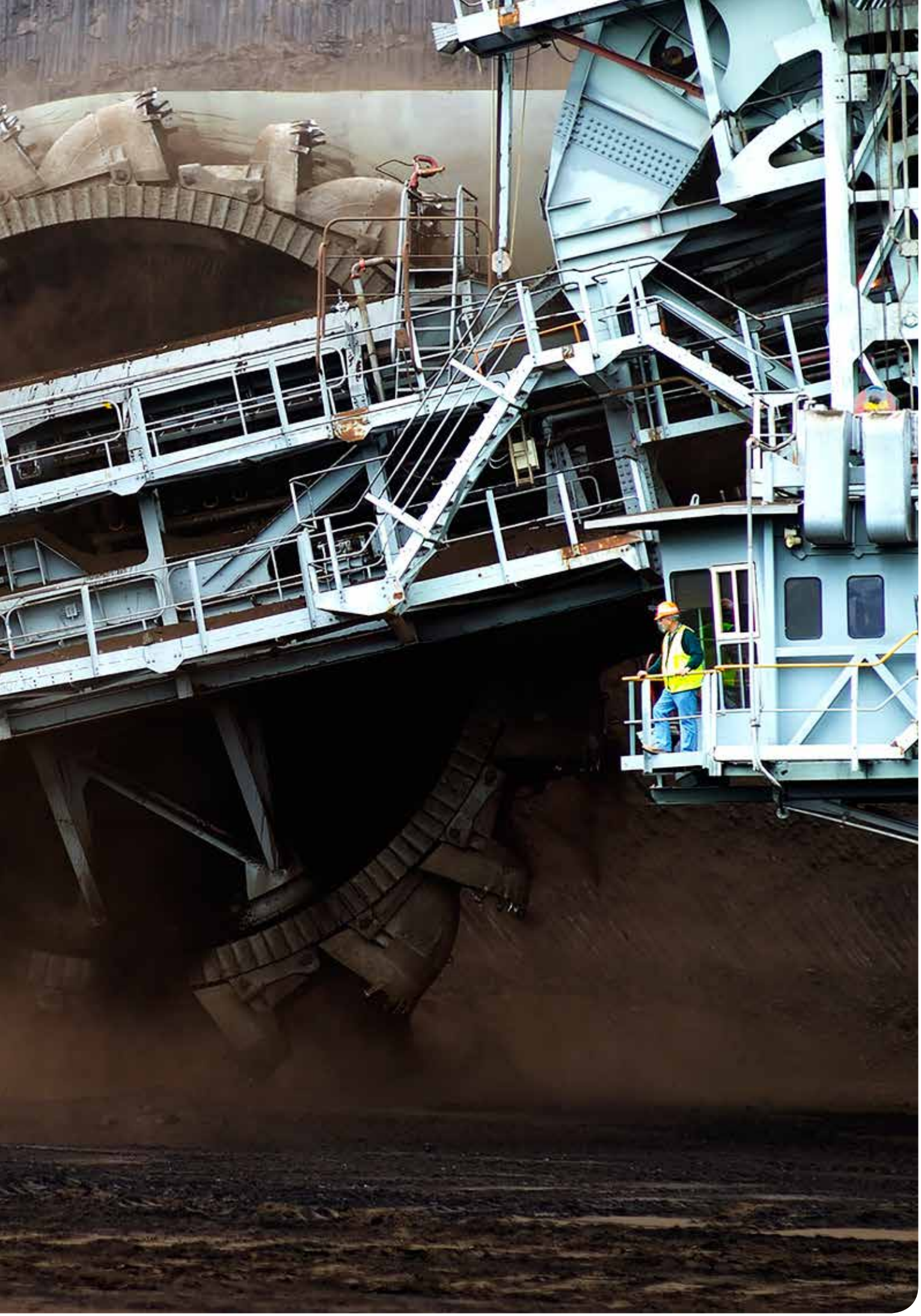
"We estimate that we have helped our clients to achieve business benefits of about A$10 million to A$25 million per dragline per year. Considering the large number of draglines that have been upgraded on Institute recommendations, the total financial benefits are estimated to run into hundreds of millions of dollars."

"WE ESTIMATE THAT WE HAVE HELPED OUR CLIENTS TO ACHIEVE BUSINESS **BENEFITS OF ABOUT A$10 MILLION TO A$25 MILLION PER DRAGLINE** PER YEAR."

Gerard Chitty, Managing Director, Maintenance Technology Institute

CASE STUDY

CAPABILITY STATEMENTS



Chisholm

Key areas of expertise

- Environmental Management
- Mining Safety
- Oil and Gas
- Mechanical Engineering
- Fabrication
- Mechatronics
- Power Systems
- Electrical Trade
- Automotive Mechanical Technology
- Diesel Fitting and Diagnostics
- Heavy Road Transport
- Heavy Mobile/Plant Equipment

Research/program delivery capabilities

Chisholm's staff are highly experienced and offer flexible and innovative approaches and solutions. The latest technology underpins Chisholm's focus with industry requirements as the key driver. Its client base, growth and ability to secure contracts are a testament to a successful client-focused approach.

Examples of recent customised training include:

- A four-year contract with Qatar Petroleum to deliver accredited training programs, consultancy services and technical instructor training in areas including instrumentation, security, process plant operations, and mechanical engineering.
- A 10 year contract with 10 power companies' colleges in China for the training of technicians in Power Systems and Renewable Energy to work in the Chinese power industry and specifically, power companies.

CHISHOLM INSTITUTE

Chisholm is a Registered Training Organisation that delivers government-funded and fee-for-service training and consultancy services to industry, business, government and community organisations. Over 38,000 people undertake training annually with Chisholm in Australia and 4,500 internationally.

Chisholm's training partners include Qatar Petroleum, China Electric Council, South East Water, Queensland Water Commission, Australian Defence Force, Abigroup, Victoria Police and Mongolian Technical College.

- For the last five years Chisholm has assisted Toyota to establish a Training Centre, to develop customised mechatronics training programs and to deliver these onsite.
- Conducting National Association of Testing Authorities (NATA) testing both nationally and internationally.
- The design and conducting of an individualised skill development program for Ethiopian Vocational trainers of trainers in automotive, electronics, mechatronics, and building; funded through AusAID.
- A continuous contract with the Mongolian Technical College to train personnel in heavy equipment for the mining industry.
- Conducting water management programs for 20 Cambodian water professionals in Australia on Integrated Water Resource Management; and development of a customised program for 15 African water specialists in small town water supply. Both projects were funded by AusAID.

Key contact

Ms Chris Louey
Executive Manager International

T: +61 3 9212 5055
E: chris.louey@chisholm.edu.au

chisholm.edu.au

GippsTAFE

Key areas of expertise

- Oil and Gas
- Instrumentation
- Occupational Health and Safety

Research/program delivery capabilities

Since 2006, GippsTAFE has been recognised for its ability to develop highly flexible and responsive programs suited to the international marketplace. GippsTAFE provides extensive training across South East Asia, particularly in Malaysia, Papua New Guinea and the Philippines.

GippsTAFE remains a preferred provider of training to many industries including electricity production and distribution, oil and gas processing and production, education, health provision, and government-regulated environments.

GIPPSTAFE

Central Gippsland Institute of Technical and Further Education (known as GippsTAFE) has a long history of providing vocational and educational training for the mining industry domestically and internationally. GippsTAFE specialises in mobile plant training for operators in the competencies to use equipment such as dredgers, cranes, tool carriers, dozers and excavators.

GippsTAFE has a campus in Melbourne and five regional campuses across eastern Victoria. It has been providing industry-recognised training solutions and customised skills-based accredited and non-accredited training for over 80 years.

Highly recognised for its international delivery, GippsTAFE continues to expand capacity to assist developing countries to capitalise on industry opportunities. Addressing skills shortages internationally is a key objective of the organisation.

The Institute's international offerings range from Certificate II to diploma-level programs, across a range of study areas including automotive, process plant technology, electrical, instrumentation, occupational health and safety, business, and training and assessment. GippsTAFE is also recognised as an Australian leader in the innovative use of e-learning technology.

GippsTAFE's Country Client Managers provide effective responses to international delivery requirements, ensuring that a culturally appropriate communication strategy is in place to meet clients' needs.

GippsTAFE's international clients include Ok Tedi Mining Ltd, Oil Search Limited and Newcrest Mining Ltd. GippsTAFE also provides expert consultancy to the Government of Papua New Guinea for its Technical Vocational Training system (TVET) and the development of an e-leaning strategy.

GippsTAFE maintains a long-term relationship with Curtin University (Malaysia), to deliver Diplomas of Process Plant Technology, Business, Occupational Health and Safety, and Instrumentation and Control Engineering, all recognised within the Australian Skills Qualification Authority. This auspicing arrangement attracts over 250 enrolments per year.

GippsTAFE's other educational partners include Australian organisation VETASSESS, in the provision of vocational education and training qualifications in the Philippines, United Kingdom and New Zealand.

Key contact

Ms Vanessa Marsh
International Consultant
GippsTAFE | International

T: +61 3 5622 8541
M: +61 407 057 583
E: vanessam@gippstafe.edu.au

gippstafe.edu.au

MONASH University

Key areas of expertise

- Mineral Exploration
- Heavy Haul Railway Technologies
- Performance Improvement of Major Equipment
- Engagement with Indigenous Communities
- Legal Frameworks for Sustainable Development
- Corporate Social Responsibility
- Condition Monitoring
- Big Data Analytics
- Optimisation and Scheduling
- Robotics and Automation
- Brown Coal Innovation
- Industrial Design
- Occupational Health, Safety and Injury
- Sustainable Resource Management
- Energy Efficiency

Research/program delivery capabilities

Monash undertakes more contract research with Australian industry than any other Australian university. The majority of this work is with leading mining companies.

Monash has have a strong track record in driving productivity gains in mining, mainly through two groups – the Maintenance Technology Institute and the Institute of Railway Technology. Their innovative engineering-based solutions have been adopted by mining companies all over the world to increase productivity and improve safety. Monash's other technology-related capabilities that enhance industry productivity are condition monitoring, optimisation and scheduling, big data analytics and robotics.

Monash's geoscientists create predictive models that guide more economical mineral exploration. Also relevant to the exploration and start-up phases, Monash has expertise in how policy, legislation, and other regulatory requirements impact the industry. Monash's capabilities include cultural heritage, native title, and human rights.

MONASH UNIVERSITY

Monash University has become the largest university in Australia, renowned for outstanding teaching, transformative research, international reach and an extensive alumni network. Monash is a global university possessing the ambition and ability to address momentous challenges. Monash has campuses in Australia, Malaysia and South Africa and major partnerships with universities in China, India and the United Kingdom.

Monash has a long history in providing research and development services to the mining industry, mainly through the Maintenance Technology Institute and the Institute of Railway Technology. Study in mining engineering at Monash combines theory and practice, covering mining engineering, technology, sustainability, community, safety, project management and teamwork, economics, communication skills, innovation and leadership.

In the production phase, Monash can add value through advanced engineering, industrial design, extraction and recovery of metals, brown coal innovation, high performance metals and corrosion mitigation.

Monash can improve business operations through:

- improving workplace safety and injury outcomes
- boosting workforce productivity
- innovating in business operations and services.

In energy efficiency, Monash's main research areas are: materials for energy harvesting and storage, renewable energy sources and optimising energy management systems. Monash has expertise in sustainable resource management and water treatment and management.

Linkages with industry include:

- BHP Billiton
- Rio Tinto
- Fortescue Minerals Group
- Vale
- BHP Billiton Mitsubishi Alliance
- Xstrata Coal
- Anglo Coal
- Peabody
- Wesfarmers
- Minera Escondida
- Hammersley Iron
- Pilbara Iron Company
- MMG Limited
- Newcrest Mining Limited

Key contact

Professor Jerry Tien
Head of Mining and Resource Engineering

T: +61 3 9902 0119
E: Jerry.Tien@monash.edu

monash.edu.au

THE UNIVERSITY OF MELBOURNE

Key areas of expertise

Engineering

- Mine area hydrological understanding
- Mine rehabilitation
- Water resources
- Groundwater analytics
- Sustainable mining
- Minerals processing
- Hydrometallurgy
- Automated planning
- Planning and scheduling
- Mine design and Optimization
- Robotics and Automation

Law

- International Mineral Law

Science

- Chemical systems
- Physics

Research/program delivery capabilities

Key University of Melbourne initiatives in mining research include:

Mine Design

Access optimisation in underground mine design: Researchers at the University of Melbourne are investigating how to optimise the network of declines (systems of ramps) and drives which satisfy operational gradient and curvature constraints so that the cost of construction and haulage over the life of a mine is minimised.

UNIVERSITY OF MELBOURNE

The University of Melbourne is a public-spirited institution that makes distinctive contributions to society in research, learning and teaching, and engagement.

Ranked number one in Australia and 34 in the world for the quality of its research, the University of Melbourne harnesses interdisciplinary research to solve some of the most difficult problems facing our world.

Research across mining is both discipline-focused and multidisciplinary in nature and the University of Melbourne collaborates with universities, governments, industry and communities worldwide to further developments cooperatively.

Students interested in careers in the mining sector may undertake relevant bachelor, masters level and research degrees across commerce, environments, the sciences and engineering.

Agile mine scheduling through contingent planning

Mine scheduling is a challenging problem for University of Melbourne industry partner, Rio Tinto Iron Ore (RTIO), which annually mines more than 200 million tonnes of iron ore. An exciting project at the University is tackling a problem RTIO faces in making its signature product, the Pilbara Blend, for which Australia is highly regarded internationally.

Making the Pilbara Blend involves taking two distinctly different ore types from multiple mines and dynamically blending them to make a greater value product with highly consistent quality. This research is exploring ways to optimise mine scheduling, taking into account the increased need for consistent quality and complexity of modern day mining operations operating across multiple mine sites with variable ore grades and increasing infrastructure constraints.

Key contact

Ms Kate Cornick
Director, Industry and Innovation

T: +61 3 9035 5785
E: k.cornick@unimelb.edu.au

unimelb.edu.au

The Melbourne: Research, Education and Training series profiles the capabilities of Victorian education providers across 13 sectors:

Advanced Manufacturing
Agriculture and Food Security
Business, Governance and Finance
Clean Energy
Creative Industries
Education and Development
Health and Communities
ICT
Infrastructure and Urban Design
Mining
Tourism and Hospitality
Transport
Water Management

For more information on Melbourne's research, education and training capabilities contact your local Victorian Government Business Office at: invest.vic.gov.au/offices

Produced by International Education Unit
Department of State Development, Business and Innovation

Level 33, 121 Exhibition Street
Melbourne Victoria 3000

T: + 61 3 9651 8109
F: + 61 3 9651 9701

investvictoria.com

STUDY MELBOURNE VICTORIA AUSTRALIA

State Government Victoria AUSTRALIA

DTPLI813Q/14