



THE UNIVERSITY OF
MELBOURNE

MELBOURNE MINING INTEGRATOR

COLLABORATING ON INNOVATIVE TECHNOLOGY
TO OPTIMISE PERFORMANCE AND DELIVER
REAL WORLD IMPACT

Through the Melbourne Mining Integrator (MMI), the University of Melbourne works with explorers, miners and mining equipment, technology and service (METS) providers to tackle some of the sector's most challenging problems.

The MMI assembles multidisciplinary teams from across the University to leverage our extensive knowledge of the mining industry, integrating new perspectives and different approaches more commonly applied in other industries such as defence, manufacturing, finance and IT.

Our considerable expertise in machine learning and artificial intelligence, data analytics, social trends, environmental management, logistics and financial assessment are already being applied within the mining industry.

Working closely with our partners, we can provide end-to-end solutions – from shaping technological problems, analysing the solutions through simulation, through to testing prototypes in our facilities and in the field.

Through the MMI we are uniquely positioned to provide an integrated view of the mining value chain and also harness the unique capabilities across Australia's most successful universities.

THREE KEY PROGRAMS OF RESEARCH

- » **Next generation digital mining**
– new techniques to analyse the large volumes of exploration and mine data to optimise mine operation and maximise value
- » **Mine planning and agile logistics**
– new techniques and mine designs to optimise operations along mining supply chains incorporating real-time responsiveness
- » **Process productivity** – improving the performance of existing unit operations and developing new systems incorporating latest technologies



BECOMING PART OF YOUR BUSINESS

MELBOURNE MINING INTEGRATOR LEADERS



MMI Research Leader, Professor Adrian Pearce

Adrian Pearce is the Director of the Melbourne Mining Integrator. An innovator in planning and scheduling, his research has improved the efficiency and robustness of a range of applications including mine planning, supply chain optimisation, robotics, logistics, air traffic management and autonomous systems in defence applications. He has contributed extensively to the research field of artificial intelligence, as well as optimisation problems, including more efficient and productive supply chain management for agile mine scheduling.



MMI Enterprise Professor Christopher Goodes

Chris Goodes has extensive experience in developing and commercialising large-scale industrial technologies, predominantly in the mining and manufacturing industries. He previously worked for Rio Tinto in the Innovation group and prior to that for the CSIRO and the Cooperative Research Centre for Polymers.

HOW TO ENGAGE WITH US

Consulting and Technology Strategy

- » Research, systems engineering and technology development
- » Survey and assess emerging technologies
- » Developing R&D projects in your company
- » Technology evaluation
- » Technology implications for policy

Research Projects

- » Contracted and collaborative research
- » Individual experts or teams of researchers

Student Projects, Internships and Placement

- » Undergraduate students could be working on your problems
- » Our PhD students undertake an internship in your company
- » Postdocs could be placed in your organisation for 1-3 years

OUR PROGRAMS

NEXT GENERATION DIGITAL MINING

The mining industry is awash with data from many sources, from exploration, mining and mobile and fixed equipment through to complex process control systems. The challenge is to use this data to make informed decisions that enhance safety and maximise value.

This research program aims to develop and deploy new techniques for analysing the large volumes of data that will be produced in the future and use this analysis to improve mine operations.

Mine sites are increasingly moving to remote and autonomous operation with remote sensing, robotics and autonomous infrastructure. In this setting, more data will be available than ever, from the increased monitoring of a material's characteristics as it moves from pit to plant and real-time knowledge of the location and status of equipment and stockpiled ore.

Next generation digital mining techniques have the capacity to:

- » facilitate reconciliation between expected and realised outcomes;
- » communicate the overall state, and predicted future state, of operations to miners in real time, given large volumes of data from varying sources; and
- » continually revise ore body models in terms of composition and processing characteristics as new data arises.

The MMI has expertise and unparalleled critical mass in data mining, machine learning, simulation and modelling, remote sensing, stream data mining, decision analytics and real options analysis.

CASE STUDY

Thickener process control

MMI has developed a new approach that allows plant operators to put more trust in a wide range of unit controllers in ore processing and separation plants, such as for thickeners. It combines expertise in physical and chemical processing models with control theory and machine learning to great effect.

Statistical machine learning is used to estimate the parameters of controllers, based on self-learning that optimises both unit operations and across the system. Artificial intelligence techniques are used for failure detection and improving the set points across different operating regimes and shifts. This aims to improve the trust of the operators in the virtual plant and controller, resulting in a more strategic, proactive and consistent operating environment to better meet production objectives.

OUR RESEARCH TEAM



Dr Ben Rubinstein Research Team Leader

Ben joined the University of Melbourne in 2013 as a senior lecturer in computing and information systems. He brings research experience from Microsoft, Google, Intel and Yahoo! in the US and IBM Research-Australia. He pursues research in machine learning, security, privacy and databases.



Professor James Bailey

- » Data and decision analytics
- » Statistical machine learning and data integration



Professor Rui Zhang

- » Data analytics for value



Professor Antoinette Tordesillas

- » Mechanics of granular media and complex systems
- » Data analytics



MINE PLANNING AND AGILE LOGISTICS

Mine planning is complex with short, medium and long-term objectives that are often competing rather than complimentary.

This research program is developing and deploying new techniques to optimise operations in mining supply chains. Our approaches cover different mining timeframes, from mine design to decisions made over short, medium, and long-term horizons. They also incorporate the capacity to rapidly respond to changes in the mining environment and adapt current plans in real time.

The ability to respond quickly to environmental dynamics, such as adverse weather or revised estimates of ore body content, allows miners to consistently meet operational production and quality targets over time.

Advanced techniques for mine design and long-term planning have the capacity to unlock more value from an ore body, achieving greater net present value and returns on investment in addition to improving safety and reducing environmental footprint.

The MMI has expertise and a substantial background in optimisation and control theory for complex networks, mine design, mathematical optimisation and mine planning across all horizons. Outcomes from MMI work have been commercially deployed and demonstrated to add significant commercial value.

CASE STUDY

MineOptima

The University of Melbourne's MineOptima planning program evolved out of almost 20 years of research into the optimisation, design and planning of complicated, underground tunnel networks.

MineOptima designs optimal equipment access layouts for underground mines, with algorithms that identify least-cost access networks for underground mines that satisfy navigability constraints while minimising development and haulage costs.

It provides a 3D rendering of an optimal decline network for a user's underground mine, taking into account operational constraints such as the decline gradient, turning circle radius and straight sections of the declines near junctions, and determines optimal locations for breakouts of subsidiary declines in the network, given the network topology.

In 2017 MineOptima was successfully acquired by an ASX-listed METS company.

OUR RESEARCH TEAM



Dr Michelle Blom Research Team Leader

Michelle is a research fellow in the Department of Computing and

Information Systems at the University of Melbourne. Her research involves developing new algorithms and heuristics for scheduling operations in large open-pit mining supply chains.



Dr Marcus Brazil

- » Network optimisation (minimum cost networks, Steiner trees)
- » Underground mine planning



Dr Nir Lipovetzky

- » Artificial intelligence
- » Machine learning
- » Automated planning and scheduling
- » Operational mine planning

CASE STUDY

Life-of-mine (LOM) planning for the Pilbara iron ore network

MMI has developed life-of-mine (LOM) planning techniques for an open-pit iron ore mine network in Western Australia's Pilbara region. New, more efficient and scalable algorithms developed for a tier-one miner are delivering a step change in the speed of options made available to mine planners, solving LOM planning problems much faster than previously possible. The approach helps optimise multiple objectives and decisions on stockpiling, practical mining constraints and financial modelling for capital expenditure. The techniques also help to free millions of dollars in cash flow and ensure an even-greater net present value over the life of the mine.



PROCESS PRODUCTIVITY

The mining industry is constantly being challenged to improve safety and increase the productivity of its assets, while simultaneously aiming to maintain or improve product quality.

This research program aims to optimise the productivity of current assets and also develop and deploy new technologies for the extraction of metals from their ores.

Advanced processing techniques have the potential to significantly improve the efficiency of mining operations. The use of column arrangements, for example, in place of mixer-settlers in solvent extraction processes can reduce capital costs and land and operational requirements, while increasing plant throughput.

CASE STUDY

Solvent extraction

MMI has developed advanced techniques for the extraction of metals from their ores based on the use of pulsed columns – a game-changing alternative to mixer-settlers. Our advanced chemical and thermodynamic models have improved plant efficiency and metal yields while dramatically reducing water and energy requirements. After demonstrating a prototype based on pulsed columns, the technique has been successfully scaled up and deployed at a major mine site, halving water use.

Improved chemicals and models that describe chemical interactions with target metals can improve plant efficiency and metal yields while potentially reducing water and energy requirements, significantly reducing operating costs and the environmental footprint of an operation.

The MMI has expertise in advanced polymers, flocculation, solid-liquid separation, rheology control and flotation, sludge thickening and dewatering, and advanced equipment and solvents for solvent extraction processes. We also work in energy-efficient comminution solutions and mineral recovery through flotation.

CASE STUDY

Minerals processing

The university has developed novel techniques in minerals processing using polymeric reagents in solid/liquid separation and froth flotation. Key outcomes include demonstrating that underflow density can be increased while reducing rheological (flow) properties to reduce pumping energy to tailings dams. This work has led to improved grade and recovery of fine iron and copper ores in flotation.

OUR RESEARCH TEAM



Dr Kathryn Mumford Research Team Leader

Kathryn is a senior lecturer in the Department of Chemical

and Biomolecular Engineering at the University of Melbourne whose research has delivered breakthroughs in separations processes, specifically ion exchange, solvent absorption and solvent extraction technologies.



Professor Peter Scales

- » Particulate fluids processing
- » Wastewater processing
- » Rheology (used in ore processing) and flocculation



Dr Anthony Stickland

- » Solid-liquid separation
- » Suspension rheology



Professor George Franks

- » Mineral processing, flocculation and colloids
- » Surface chemistry
- » Mining reagents and flotation



Dr Iman Shames

- » Control theory and systems



PARTNER AND COLLABORATE WITH US

From complex multi-partner research to short consulting projects, find out how your business can engage with the University of Melbourne.

Contact: Professor Adrian Pearce, Melbourne School of Engineering

Email: mining-research@unimelb.edu.au