Delivering a step change in value for METS and Miners

From silos to integration

The MI4 CRC aims to fundamentally change the mining value chain, by moving from silo-based decision making to a fully integrated systems approach. Implementation will require profound social and technical change but has the potential to transform the mining industry.

Mining Industry 4.0

Industry 4.0 is defined as “the next phase in the digitization of the manufacturing sector, driven by the astonishing rise in data volumes, computational power and connectivity, especially new low-power wide-area networks; the emergence of analytics and business-intelligence capabilities; new forms of human-machine interaction such as touch interfaces and augmented-reality systems …”.

Mining Industry 4.0 will build upon this principle by overlaying the unique variability inherent in natural resource systems. The MI4 CRC aims to provide an overarching framework and toolkit for implementation.

The MI4 CRC will reimagine the mining value chain through the application of industry 4.0 principles. This will deliver significant reductions in both capital (CAPEX) and operating (OPEX) costs compared with current approaches. Reductions up to 50% are achievable based on experience from other industries. This offers the potential to make current uneconomic deposits viable and make existing mines more competitive.

MI4’s Vision

To achieve a step change in the conversion rates of Australia’s “mineral resources” to “ore reserves” through the adoption of industry 4.0 principles across the mining value chain. In doing so the MI4 CRC research outcomes will facilitate:

- Improved safety outcomes and reduced environmental impacts through precision mining,
- Significant reductions in capital and operating costs for greenfield and existing mines,
- A dramatic increase in the conversion of Australian mineral resources to economic reserves, creating new mines, new jobs and unlocking billions of dollars of value,
- The growth of the Australian METS sector by supplying to the Australian mining industry and growing international export opportunities, and
- Preparing the workforce of the future, well equipped in industry 4.0 practices.

The MI4 CRC will create new opportunities and value for METS and miners by reimagining the mining value chain.

Developing the prospectus

This prospectus has been developed following extensive consultation with METS and miners throughout 2018, including workshops and a series of one on one interviews. The industry feedback was that while some progress has been made, the adoption of industry 4.0 principles has been largely piece-meal and the gains achieved while significant are modest compared with the potential.

The proposed themes and key activities outlined in this prospectus will be further refined through active industry engagement. Expressions of interest to participate in this CRC bid are sought from miners, METS and other key stakeholders, with programs tailored for organizations of all sizes and positions in the value chain.

1. Mining Equipment, Technology and Services
Context – Why the MI4 CRC?

Challenges to Australia’s position as a global mining leader

MI4’s vision is to achieve a step change in the conversion rates of Australia’s “mineral resources” to “ore reserves” through the development and deployment of industry 4.0 principles throughout the mining value chain.

The first wave of digital technologies applied to the mining industry has largely focused on the automation of existing equipment and processes, together with improved data collection and analysis. This has allowed for important but incremental improvements to be made. The MI4 CRC is based on the premise that step change gains can be achieved through the adoption of industry 4.0 principles. This will allow for radical process redesign and operation. The MI4 CRC will work with METS and miners to achieve these gains.

Australia is a global powerhouse in the mining sector and home to a modern and growing export focused METS sector. Together Australia’s mining and METS sector contributed some $133.2B in gross value added to the Australian economy in 2015-2016, with an estimate of $10B to $40B contribution directly from the METS sector.

The METS sector has been designated as an area of high priority by the Commonwealth government and in Australia is recognized as a key industry “high tech” growth sector. The global demand for Australia’s mineral and metal exports is strong, with continuing growth predicted resulting from ongoing urbanization particularly in China and India. The growing trend of electrification in transport and industry to reduce greenhouse emissions is further fueling metal consumption.

While a global leader, the Australian mining and METS sectors faces a range of challenges:

- Increasing scarcity (and complexity) of the in-ground resource base, coupled with the challenge of finding large, high quality mineral deposits at or close to the surface,
- Increasing community expectations, and challenges with respect to social license to operate and end of life mine rehabilitation,
- Adoption of the UN Sustainable Development Goals,
- Increased pressure to reduce energy consumption, greenhouse gas emissions and waste,
- Increasing global competition through consolidation of service and equipment providers present challenges to the Australian METS industry, and
- Having a workforce prepared for mining industry 4.0.

Initial proponents of the Mining Industry 4.0 (MI4) CRC

[Logos of various institutions involved in MI4 CRC]

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4. www.sustainabledevelopment.un.org
**Australia is not reaping full value from the global “Digital boom”**

The pace of global technological development in a range of industries (e.g.: manufacturing, defence, health and oil and gas) has been rapid over the last decade, and particularly in the application of industry 4.0 principles. The mining industry in Australia has been slower to respond. Focus has been on the automation of existing equipment and better data analysis. While there are pockets of best practice to be found, there is much catching up to be done. According to McKinsey, “mining is in the bottom quartile of digitization compared with other industries”.

Mine sites are becoming increasingly flooded in a sea of data but turning data into decisions is problematic.

To be successful, mining industry 4.0 principles need to be embraced and supported by staff and other key stakeholders. The technology itself is often of secondary importance. The MI4 CRC aims to support METS and miners to address the barriers to entry of new technology including the critical issues of change management, encouraging a suitable culture of innovation, provision of education and training and by understanding the regulatory and governance frameworks.

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**Learning from other industries**

Industry 4.0 refers to the fourth industrial revolution:
- First industrial revolution – mechanization through water and steam power
- Second industrial revolution – mass production and assembly lines using electricity
- Third industrial revolution – adoption of computers and automation
- Fourth industrial revolution – smart and autonomous systems fueled by data and machine learning.

The mining industry can learn from other industries while recognizing there are important contextual differences. A key premise of manufacturing is to closely control the quality and consistency of the inputs and to minimize variation. Mines however, are typically highly heterogeneous with the composition of ore in the ground varying greatly at the macro (hundreds of meters) through to the micro (sub-micron) scale. Like manufacturing, the aim is to reduce variation and in mining to produce a uniform input into the milling process.

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6. Forbes Magazine, “What is Industry 4.0”, B. Marr, September 2nd, 2018
The case for Australia

Why now?

Minerals are becoming more difficult to find, are generally of lower grade and more challenging to process. Deeper mines are being developed posing additional safety challenges and productivity hurdles. Government regulations and policies need to keep a pace with technology and social developments.

The mining industry also faces challenges related to social operating license and the need for improved environmental performance. The deployment of mining industry 4.0 principles offers great potential to assist. The elimination of waste is critical to the UN Sustainable Development Goals.

The imperative for “action now” is compelling:

- The rate at which digital technologies are being developed is exponential, and the Australian mining industry is yet to fully deploy and capture the benefits,
- Australia is at risk of (or arguably already is) falling behind other countries (notably Canada, Chile and Sweden7) in the digital mining space. The MI4 CRC aims to build a long-term framework while delivering short term outcomes, and
- The depth and breadth of skill sets required, including researchers, METS and miners, means a CRC is an ideal delivery platform. MI4 will also leverage international researchers to provide world’s best practice.

For miners

The MI4 CRC will provide industry 4.0 solutions that directly address current barriers to unlocking value in the mining industry, such as:

- Lack of interoperability between systems and platforms,
- Breaking down silos between unit operations in the value chain,
- Variable sensor capability and data quality specifically suited to mining,
- Lack of tools and capacity to turn data into information for improved decision making,
- Improved risk and sustainability management,
- Providing trial sites for METS and miners to explore digital solutions in a risk mitigated fashion, and
- Engaging with Government at all levels so regulation keeps a pace with industry 4.0 implementation.

Critically, MI4 will provide a platform for preparing the workforce of the future, through targeted training offerings for existing employees in the METS and mining sector and via post graduate programs.

For METS

The Australian METS sector has been a leader in the development of new technologies for the mining industry. The creation of projects within a CRC environment offers many benefits:

- Access to operational mining sites and data enabling the acceleration of development and deployment of new technology solutions,
- Promulgation of industry standards to assist with interoperability,
- The ability to work with multiple end users rather than one customer, thus expanding and accelerating the range of commercialization opportunities, and
- Exposure to MI4’s network of researchers, industry partners and end users, including access to the best approaches and technologies from other industries.

The value proposition

The Australian METS sector is a key provider to the Australian mining and resources industry and has a global reputation for innovation. Global demand for commodities continues to increase. When coupled with low discovery rates and a long-term decline in the grade of future resources, a step change in approach is critical to improve profitability. Current mining technology is limited to converting an estimated 30% to 40% of Australia’s mineral resources, which have been identified as having reasonable prospects for economic extraction. At this conversion rate most already identified resources will not be developed and remain as “stranded assets”.

MI4 Value proposition

The step change reduction in capital intensity and operating cost in mining has, over the next 10 years, the potential to deliver in excess $320 billion for the mining & metals sector (equivalent to 2.7% of industry revenue and 9% of industry profit), to eliminate more than 600 million tonnes of CO₂ emissions and the potential to save lives by removing people from harmful energy through automation.

For example, there is an escalating requirement to mine more copper in the next 25 years than we have mined in entire human history. This is being propelled both through urbanization and electrification of energy systems.

8. Based on Measured and indicated Mineral Resources and Ore Reserves as aggregated per commodities by Australian Geosciences. Definitions of Mineral Resources and Ore Reserves as per the JORC Code 2012.
9. World Economic Forum (WEF, 2017) “Digitalization could generate ~$320B industry value over the next decade, ~$190B mining + ~$130B metals sector (2.7% of industry revenue & 9% industry profit); reduce CO₂ emissions by 610Mt; and improve safety - 1000 lives saved (10% decrease in fatalities), 44,000 injuries avoided (20% decrease in injuries).”
Reimagining the mining value chain – the Surgeon’s scalpel

The application of industry 4.0 principles provides the opportunity to fundamentally redesign the mining value chain. From a precise knowledge of what minerals lie under the surface and how they are best processed, the objective is to minimize the amount of waste material that is mined, processed, transported and then ultimately discarded. In short, precision mining. Modern keyhole surgery provides a useful analogy.

**Keyhole surgery** is a minimally invasive surgery. It provides accuracy and allows more rapid patient recovery and rehabilitation.

The application of digital and industry 4 techniques will allow “Precision mining” to occur.

Like keyhole surgery, digital mining offers the potential to pinpoint and selectively extract the minerals and metals of interest. The aim is to:

- Maximize the extraction of valuable ore and leaving as much waste material in the ground.
- Thereby minimizing disruption to the landscape and making rehabilitation quicker, easier and more complete.
- Provide a safer working environment by minimizing the contact between people and machines.
- New mines can be designed in a very different way, with lower CAPEX and OPEX by removing human contact.

For new mines, digital mining will unlock previously uneconomic ores. For established mines, the application of digital technologies has the potential to increase NPV, ROI and increased cash flow.

No one individual miner, METS company or researcher has the scale, breadth or expertise to fully develop and capture these benefits. The MI4 CRC will harness both contextual mining knowledge with broader technology related opportunities to create value. Unleashing the potential of industry 4.0 will require:

- Mining contextual knowledge,
- A deep understanding of industry 4.0 principles,
- Organizations prepared to accept and maximize the benefits (a combination of innovation culture, training and capabilities), and
- Appropriate government policy settings and regulations.

Previous efforts have faltered where one or more of these enablers has not been present. All are critical.

The MI4 CRC will deliver a safer, more environmentally acceptable and productive solution to the world’s growing demand for minerals by enabling fully autonomous and integrated mining operations along the entire value chain.

This will grow the Australian mining sector through enhanced competitiveness, enable new orebodies to be mined thereby increasing reserves, and enable the METs sector to deliver mine automation and integrated mining platform solutions.
Themes

Detailed project outlines will be developed in close collaboration with industry partners to ensure maximum alignment and impact. At this stage four cross cutting and interrelated research themes are proposed to stimulate engagement:

1. **(Systems) Integration:**
   - Open platforms and architectures for data, processes and insights
   - Systems integration
   - Inter-operability solutions
   - Value chain driven decisions (dynamic resource models)
   - Encouraging entrepreneurial METs and start-up contributions

2. **(Systems) Integrity**
   - Trusted autonomous mining systems (enabling autonomous mining)
   - Systems engineering (system of systems)
   - Risk management and measurement
   - Maintenance support for autonomous systems
   - Cyber resilience

3. **Implementation (& Deployment):**
   - Agile change management
   - Business process modelling
   - Systems re-design & rapid deployment
   - Organization model structures to support transition
   - Government regulations & frameworks to promulgate change

4. **Intelligence (& Co-learning):**
   - Fostering the workforce of the future
   - Human machine interfaces & digital twins
   - Artificial intelligence & human-machine co-learning
   - Targeted training programs & skills development
   - Social adaptation to mining industry 4.0 (meeting sustainability goals)
   - Postgraduate programs for future employees
How do I participate?

What is a CRC

CRCs are independently run entities which are jointly funded by industry participants, research organizations and the Federal Government for up to 10 years. Since the inception of CRCs in 1991, 210 have been funded. Over the ensuing years, CRCs have undergone several independent reviews, all concluding that the CRC program has delivered significant economic, environmental and social benefits to Australia.

The Australian Government’s CRC program is a proven model that supports industry-led collaborations between industry, researchers, government and the community within Australia and internationally to develop new technologies, products and services. In 2018, there were 31 active CRCs in Australia.

There are many advantages for companies (small, medium and large) participating in the CRC process, including access to leading research providers, greater insights into the mining value chain, learning’s from other industries, funding leverage and networking opportunities.

The CRC bid process is highly competitive. The MI4 CRC will bid into the 2019 Round 21 Federal Government call for CRC submissions.

Next steps

By participating in the MI4 CRC bid process and subsequent formation, organizations will be able to provide input into the research areas, so they are aligned with their needs.

Given sufficient industry support, the intent is to submit an application for the MI4 CRC in the Round 21 CRC bid phase, occurring from March 2019 through to March 2020.

We actively encourage Australian (research, industry and government) and international organizations to participate in the bid phase to influence and drive the bid strategy and content. Activities during this phase include:

- Establishing a bid team to prepare deliverables required for the Stage 1 bid,
- Engaging with industry, government and research institutes to refine the scope and confirm the participation agreement,
- Preparing research project agreements with core research institutes and industry participants to build a CRC budget, and
- Preparing a bid phase budget.

Participants can join the MI4 CRC bid at any time during the bid phase. Proponents contribute an equal share to bid costs, notionally $20,000 to $30,000, depending on the number of proponents.

With a successful CRC outcome, bid phase proponents will join the CRC as Essential Participants, and their CRC fees for year 1 are reduced by an amount equal to the funding provided in the bid phase.

Once funding has been announced the CRC is set up, this includes establishing initial governance structures (appoint Chair, Board and CEO) and working with government to finalize the funding agreement to start in July 2020.
**Term and participation levels**

The term of the MI4 CRC is proposed to be 7 years. Overlaid on this timeframe the MI4 CRC will adopt a project horizon of 3 years or less, in order to provide timely impact and match the pace of change in technology development. This will balance the need for readily adoptable industry solutions and also recognizing the profound nature of the industry transformation required.

Four participant levels are contemplated as follows (all cash contributions p.a.):

- **Core participant:** $300,000 p.a. and above
- **Key participant:** $150,000 – $299,999 p.a.
- **Associate participant:** Up to $150,000 p.a.
- **Affiliate participant:** Project by project basis

In addition, participants will be encouraged to provide in kind resources to strengthen the technology transfer process.

**Indicative Timeline**

The following dates are indicative, and subject to confirmation by the CRC program.

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<td>Collect expressions of interest and define research programs</td>
<td>Lodge round 1 Expression of Interest</td>
<td>Further refine bid, value proposition and finalize partners</td>
<td>Lodge round 2 Full submission including business case</td>
<td>Interview process</td>
<td>Funding outcomes expected</td>
<td>MI4 CRC commences</td>
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**Contact**

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