



**METS
IGNITED**

*Engage
in our future*

MINING INNOVATION KEY MINING INDUSTRY CHALLENGES



JUNE 2017



Australian Government
Department of Industry,
Innovation and Science

Industry
Growth
Centres

ABOUT METS IGNITED

Australia's mining equipment, technology and services (METS) sector is globally connected and financially robust. Contributing \$86 billion to the Australian economy and supporting half a million jobs, the METS sector plays a significant role in the nation's prosperity.

The Australian Government has established Growth Centres in six sectors. These Growth Centres, including METS Ignited Growth Centre, are front and centre of Australia's innovation policy. The METS sector was chosen as the government recognised its composition of agile entrepreneurial SMEs, global competitiveness and growth potential based on Australia's recognised research capabilities and scale, and its leading-edge mining sector.

More than 55 percent of Australian METS companies are exporters and many are world-leaders in their markets. Further, the emerging Industry 4.0 will provide a new wave of opportunities for the METS sector. It is the role of METS Ignited to work closely with industry to increase collaboration, implement initiatives that will accelerate the commercialisation of innovation, and leverage industry initiatives to grow exports.

In this age of innovation through collaboration, the Australian METS sector has an opportunity to explore and develop blue sky projects that will create new global markets. METS Ignited, through its collaborative Project Funds, will look to support the most commercially attractive opportunities where industry working together can accelerate economic development.

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Introduction

This document examines present and emerging themes for innovation from a mining perspective and briefly overviews the themes from a METS perspective.

Through understanding the miners' business needs and drivers, the METS sector can:

- › Build collaborative projects around these needs
- › Overcome barriers to innovation, and
- › Find matched funding, provision of pilot sites and support.

Activities supporting the success of this approach may also include establishing sandpits, test-sites and living labs to further address technical and integration risks.



Key mining industry challenges

Based on extensive industry consultation the major innovation themes were identified and reduced to a short-list of “mining industry challenges”.

These challenges demonstrate customer demand, which is critical to addressing and overcoming the innovation barriers commonly experienced by METS companies.

The intention of identifying the miners’ innovation needs is to build collaborative projects around satisfying these needs, reducing the barriers to innovation, and easing the burden of finding matched funding, provision of pilot sites and support.



The key mining industry challenges identified are:

- › Deeper, continuously up to date, understanding of the resource base
- › Boosting productivity and maintenance performance through analytics, connectivity and IoT
- › Optimising material and equipment flow, towards a continuous mining and processing mindset
- › Improving performance and reducing harm through mechanisation and automation
- › Selective mining and processing to boost processing intensity
- › Novel mining and processing addressing difficult and presently uneconomic orebodies (e.g. low-grade)
- › Reducing mining’s footprint including boosting safety and environmental performance, and improving stakeholder relations
- › Improving exploration for deep and remotely located minerals

The following pages summarise the challenges, describe the current state of knowledge and products, the gaps that exist, an assessment of the ease with which solutions can be achieved (where tangible progress within two years is desirable), and the likely impact that a solution will have on the industry. In some cases specific topics are suggested for priority.

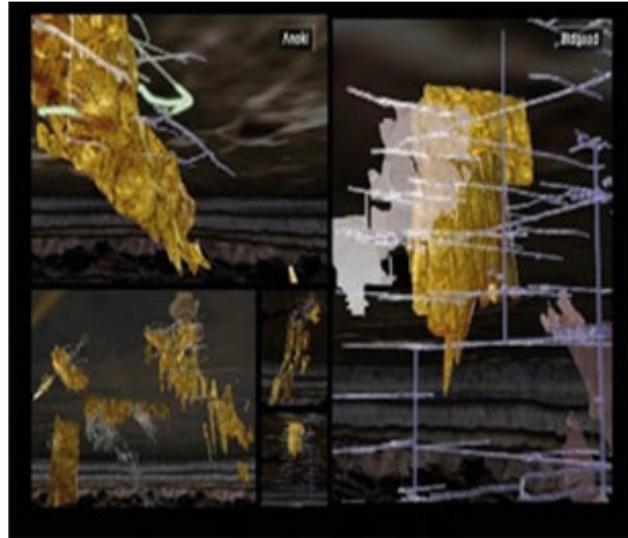
Challenge

Deeper, continuously up to date, understanding of the resource base

Description / rationale

Current state / gaps: Several of the software providers have emerging offerings in this area. This usually involves better connections between their existing modelling and planning tools. There are gaps in “closing the loop” with appropriate sensing information (e.g. measure while drilling data from production drills, plant/processing data, logistics information). Several research groups also have efforts in this and surrounding spaces (e.g. CSIRO Minerals, Curtin University).

Ease: The theme resonates with miners on several levels. The data and expertise to address this area lies across several disciplines but tangible progress could be made in a 2 year period.



Impact: This theme will enable miners to deal with the different planning and execution stages in a far more cohesive way and may identify previously “hidden” opportunities.

Its METS impact will be more modest but its application is likely to highlight systemic issues within the mining processes leading to more METS activity. Addressing interoperability for orebody modelling, planning and execution systems could open up new business models.

Specific topics / calls for action could include:

- > Exploration technologies and real-time exploration data processing
- > Interoperability and data standards for orebody modelling and mine planning
- > Real time orebody modelling, material tracking, and operational data integration
- > Multi-resolution, multi-attribute models for a single source of the truth
- > Automated reconciliation
- > New techniques and sensing for inferring orebody characteristics

Challenge

Boosting productivity and maintenance performance through analytics, connectivity and IoT

Description / rationale

Current state / gaps: The theme is addressed within most mining organisations already. Increasingly, miners are looking outside for assistance. Numerous companies and R&D groups offer services in this space, however, the offerings are somewhat disjointed. Ideally, the work requires three areas: (1) Mining domain expertise; (2) Data scientists, analysts and technologists; (3) Data engineers (to perform data “wrangling”).

Ease: This theme resonates with the miners and it could readily be addressed in a 2 year timeframe. Much of the data exists to allow better decision making, it simply isn’t used. The technical capability exists it just needs to be brought together in the right way.



Impact: The mining impact will be to boost productivity and maintenance performance, which will hit both cost and revenue.

The METS impact is likely to be more modest but its application will highlight systemic issues within mining processes, leading to more METS activity.

“Digital mining” is an area where Australia could take a dominant role, given the leading position taken with Remote Operations Centres, emerging Centres of Excellence, and the strong domain knowledge within the sector.

Specific topics /calls for action could include:

- > Towards zero unplanned maintenance for critical assets/components.
- > Real-time monitoring of performance against plan
- > Solutions and platforms for reducing adoption costs and integration risk
- > End to end value chain optimisation
- > Integrated schedule optimisation (e.g. production, maintenance, processing, logistics) incl. integration with execution systems
- > Automated and real-time bottleneck analysis
- > Turning data into information and decision support tools

Challenge

Optimising material and equipment flow, towards a continuous mining and processing mindset

Description / rationale

Current state / gaps: Mining and several of the OEMs are investigating new cutting technologies towards “continuous mining” in both open cut and underground. However, the issues of mindset and culture change are presently not well addressed.

Ease: This theme appeared from several of the miners, where there is some overlap with the “analytics/IoT” theme. Addressing it would likely require significant cultural change, as it affects different elements in the value chain. Parts of the work, e.g. tool development for real-time measurement of plan compliance, could be developed within 2 years. Broader cultural and mindset change will take longer.



Impact: Addressing this will be of high impact for mining. Like the analytics/IoT theme, its METS impact is likely to be slightly more modest but its application will highlight systemic issues within mining processes, leading to more METS activity.

Specific topics /calls for action could include:

- > End to end value chain optimisation
- > Tools for developing a continuous mining and processing mindset
- > Integrated schedule optimisation (e.g. production, maintenance, processing, logistics) incl. integration with execution systems
- > Automated and real-time bottleneck analysis
- > Theory of constraints type tools for mining

Challenge

Improving performance and reducing harm through mechanisation and automation

Description / rationale

Current state / gaps: Three R&D groups have historically been active domestically: Australian Centre for Field Robotics (ACFR), CSIRO, and CRCMining. CRCMining and CSIRO have since merged into Mining3, however much of the robotics and automation capability has dispersed. ACFR has an exclusive arrangement with Rio Tinto, and the focus there has shifted away from equipment automation. There is a real opportunity to create a far more cohesive effort in this space amongst Australian R&D providers and METS companies. The space is currently dominated by global OEMs (Caterpillar and Komatsu).

Ease: This is a theme that appeared strongly through the miners, so it resonates. There are elements within the theme which may be possible to achieve within a 2 year timeframe but the broader challenge is likely to take far longer.



Impact: Australian mining companies have taken a leading position in the roll out of automated mobile equipment including drilling, haulage and excavation both for surface and underground operations. This has required the development of significant expertise in automation and control, system and process integration, specification and acceptance testing, business case justification, maintenance and support, and regulatory compliance. Only a very small percentage of the global fleet/operations are presently automated. There is opportunity to apply the concepts to existing fleet for faster and broader impact. The incumbent OEMs will eventually turn their gaze to this area – if Australian METS is to make a difference it needs to act quickly.

Beyond the existing applications, there is a far broader scope for automation and robotics in mining covering other fixed and mobile equipment, mixed fleet, equipment / system choreography and orchestration, and exploitation of up and downstream business processes and value levers.

Specific topics /calls for action could include:

- › Standardisation/commoditisation of automation processes, including integration with surrounding mining/processing activities
- › Interoperability platforms for automation and remote control, including products and services within those platforms
- › Development of retrofit automation systems to apply to existing fleet
- › Development of operator assist / partial automation systems for existing fleet
- › Tiered maintenance and support offerings for automated fleet
- › Business / benefits case services for automation technologies
- › Robotics and automation applied to maintenance and other tasks

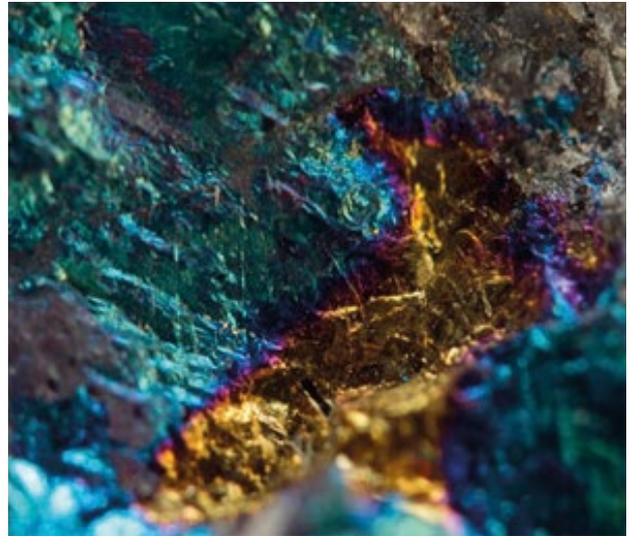
Challenge

Selective mining and processing to boost processing intensity

Description / rationale

Current state / gaps: The most active group in this space is CRC-ORE who are progressing concepts including “grade engineering” which seeks to perform separation based on particle size (e.g. through differential blasting) at the mine face. The University of Adelaide have proposed a programme addressing this area, including applying principles of “lean manufacturing” to mining.

Ease: Selective mining and processing was a strong theme from the miners. There are parts of the technology/processes that could readily be developed / deployed within 2 years. More sophisticated changes may require modest capital investment, which could be more challenging.



Impact: Putting less waste and more ore through the plant enables a better use of assets, and potential to positively impact return through volume increases, cut-off grade changes and so on.

There will likely also be some METS sector growth as a result, particularly around expertise/services, sensing and equipment supply. Australia could also take a dominant position in these approaches.

Specific topics /calls for action could include:

- > On-line ore characterisation sensors from blast scale to product
- > Real time waste characterisation for improved environmental decision making
- > Improving ore recovery, fragmentation and breakage
- > In-situ recovery technologies
- > Applying lean manufacturing principles to direct ore to most economic process
- > Selective mining

Challenge

Novel mining and processing addressing difficult and uneconomic orebodies

Description / rationale

Current state / gaps: Several Australian companies address the novel processing space, including Core Resources and Gekko. R&D groups like SMI's JKMRC and the University of Adelaide's Institute for Minerals and Resources are also active in the area. Efforts in this space could be more coherent.

Ease: This theme appeared from many of the miners. Delivery of tangible outcomes in the <2 year timeframe required by the Project Fund is unlikely. Much of the technology and capability exists locally but is challenged by opportunities to test in realistic environments.



Impact: New methods for mining and processing are needed to address what will be more challenging orebodies, in more challenging locations. This theme is critical for the miners, as it is for METS.

Creating and exploiting capability in In Situ Recovery (ISR), extraction and processing of low-grade ores, small scale robotic mining, etc. could allow Australia to take a dominant position in what is an emerging and critical area of need.

Specific topics /calls for action could include:

- > Robotics and automation for areas too risky or expensive to send humans
- > Extraction and processing of low-grade ores
- > Waste and tailings re-processing technologies
- > Technologies for Rare Earths and resources with complex mineralogy
- > Processes and technologies addressing challenging ground conditions

Challenge

Reducing mining’s footprint including boosting safety and environmental performance, and improving stakeholder relations

Description / rationale

Current state / gaps: Various R&D providers including SMI, CSIRO Minerals, University of Newcastle, UTS, and others offer capability in these areas. CRC CARE “brings together industry, government, science and engineering to prevent, assess and clean up environmental contamination”. The proponents of CRC CARE have proposed another CRC on “environmental management in the resources sector”. This could provide a more coordinated vehicle to address these matters more holistically.

Ease: This is a theme that appeared strongly through the miners, so it resonates. There are elements within the theme which may be possible to achieve within a 2 year timeframe. Broader challenges will take longer. Resources and capability by and large exists to respond to the challenge.



Impact: Social license issues are a recognised emergent threat for mining. Mining deals with imperatives “when it needs to”.

However there is likely enough discord with mining’s stakeholders that miners will be willing to engage on this topic. The impact for METS could be enormous given that these challenges exist globally.

Specific topics /calls for action could include:

- > Enhanced energy and water efficiencies for mining (e.g. towards a waterless mine)
- > Real time waste characterisation for improved environmental decision making
- > Safety technologies and products
- > Avoiding the need for tailings storage and effluent control beyond the life of mine
- > Products and services to reduce non-technical risk (e.g. community engagement, tools for determining sentiment, etc.)
- > Emissions, energy, noise and dust monitoring, mitigation and reduction
- > Mine remediation and rehabilitation
- > Battery electric vehicle technologies
- > “Closed loops” around energy, mine products and by-products

Challenge

Improving exploration for deep and remotely located minerals

Description / rationale

Current state / gaps: The theme has been addressed by the Deep Exploration Technologies CRC (DET-CRC), which is proposed to evolve into a new CRC for Minerals Exploration (MinEx). CSIRO Minerals and Exploration and various universities (e.g. the Western Australian School of Mines) are also active in this space. The area is also addressed by the AMIRA roadmap for Exploration Under Cover, which will guide future R&D efforts.

Ease: This theme resonates with the smaller and mid-tier miners, as well as explorers. Some technologies flowing out of CRC-DET could generate outcomes in under 2 years.



Impact: The impact will primarily be for miners, with some participating METS companies also able to benefit (e.g. Imdex, Boart Longyear, associated smaller METS players). The impacts

are likely to be longer term in identifying new resources to be exploited. Beyond any technology development period, new mine development is typically of the order of 7-15 years.



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