



MANDELA MINING PRECINCT
MINDS FOR MINES



ADVANCED OREBODY KNOWLEDGE

“Glass rock – Seeing into the rock”

The main focus of the Advanced Orebody Knowledge programme, one of six programmes of the South African Mining Extraction, Research, Development and Innovation (SAMERDI) strategy is to provide mine planners, rock engineers, geologists and other decision-makers with information and knowledge that will contribute to optimal extraction and zero harm objectives. This knowledge is required ahead of mining to adequately inform day-to-day tactical as well as long term strategic decision-making.

Key Advanced Orebody Knowledge questions to be addressed are:

- ✦ Where is the reef located?
- ✦ How much metal is there?
- ✦ What structures are present that are impeding extraction?

While the programme is centred on the field of in-mine geophysics, a multi-disciplinary approach, involving other fields such as rock engineering, mining engineering and geology would be beneficial.

The Advanced Orebody Knowledge Research Plan can be sub-divided into four phases:

- i. Review – Gaining a better understanding of the relevant in-mine environments, to refine the user requirements thereby enabling the matching of potential technology solutions to specific problems;
- ii. Technology assessment – Conducted in parallel with the first phase with the aim to assess the state-of-technology, and will involve a comprehensive testing of promising technologies and quantifying the value that these solutions might offer;
- iii. Optimisation/Implementation/Integration – Increased focus on developing the most promising technologies to work more effectively and efficiently, and integrating these technologies with the mining production cycle;
- iv. Knowledge transfer – The final phase of the programme will focus on demonstrating solutions to industry and disseminating and transferring knowledge.

The four phases, and how these relate to the three years planned in SAMERDI Phase 2, are visualised in the Advanced Orebody Knowledge roadmap.

The other five programmes of the SAMERDI are: Longevity of Current Mines; Mechanised Drill and Blast; Non-Explosive Rock Breaking; Real-Time Information Management Systems; and Successful Application of Technologies Centred Around People.

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LONGEVITY OF CURRENT MINES

“More from the same, with the same”

The Longevity of Current Mines thematic area, one of six programmes of the South African Mining Extraction, Research, Development and Innovation (SAMERDI), is aimed at improving mining practices and procedures particularly for established mines, already constrained by their infrastructure. The aim is to prolong their sustainability, thereby maintaining current jobs.

The objectives of the programme are to:

- 1.** Improve Occupational Health and Safety performance;
- 2.** Increase the efficiency of extraction; and
- 3.** Reduce costs.

These will be achieved through the use of more efficient systems of the mining cycle, developed by the Longevity of Current Mines programme.

The work will entail processes of documenting and analysing the challenges and issues (within the mining cycle) experienced by mining companies of this description, within the gold and platinum sectors.

The programme is geared towards identifying gaps in the mining cycle that prevent the achievement of one quality blast per day. A quality blast in this context is a blast that meets mine standards, which include; the rate of advance, breaking accuracy, quantity of explosives used, safety, fragmentation of rock, the shape of the face, etc.

If a quality blast per plan is achieved, the overall objectives of the programme as it pertains to occupational health and safety improvement, efficient extraction and cost reduction, will be possible.

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MECHANISED DRILL & BLAST

“Mining safely and effectively, with zero exposure”

The Mechanised Drill & Blast programme, one of six pro-grammes of the South African Mining Extraction, Research, Development and Innovation (SAMERDI) strategy, aims to provide sustainable mechanised solutions to the gold and platinum mining industries by introducing disruptive technologies to facilitate:

- ✦ Zero harm; and
- ✦ Achieve financially sound underground mining operations with consistent production rates at optimal cost

These aims will be considered for each process within the mining cycle such as:

- | | |
|-------------------------------------|------------|
| ✦ Early entry and temporary support | ✦ Drilling |
| ✦ Charging and blasting | ✦ Cleaning |
| ✦ Permanent support | ✦ Tramming |
| ✦ Services | |

The impact of the research includes (safe and profitable mining operations):

- ✦ Safer mining operations by the implementation of workplace transformation;
- ✦ Efficient mining operations by improving the skill level of the workforce;
- ✦ Shift in volume to “quality volume” production e.g. less or no dilution by providing customised mechanised solutions;
- ✦ Maximising “quality volume” production by implementation of innovative solutions to increase machine availability and utilisation; and
- ✦ Ultimately, financially sound returns with an increase in the reserve statement.

The objectives of the programme are as follows:

- ✦ Use mechanised technology to maintain specified safety standards when accessing new reserves;
- ✦ Increase the reserves within targeted operations using mechanised technologies;
- ✦ Increase the efficiency of mining operations by implementing disruptive technologies to existing mechanised operations for improving availability and utilisation;
- ✦ Lay the foundation for the ultimate business objective of achieving 24/7 mining operations within the gold and platinum industries by providing mechanised solutions to facilitate continuous mining;
- ✦ In cases where original equipment manufacturers are unable to provide a commercial solution, the design and production of such equipment will be conducted locally;
- ✦ Assist in the development and implementation of the Technology Assessment and Readiness Atlas; and
- ✦ Pursue any prototypes developed in the programme and highlighted as feasible with a partner within the Mining Equipment Manufacturers of South Africa.

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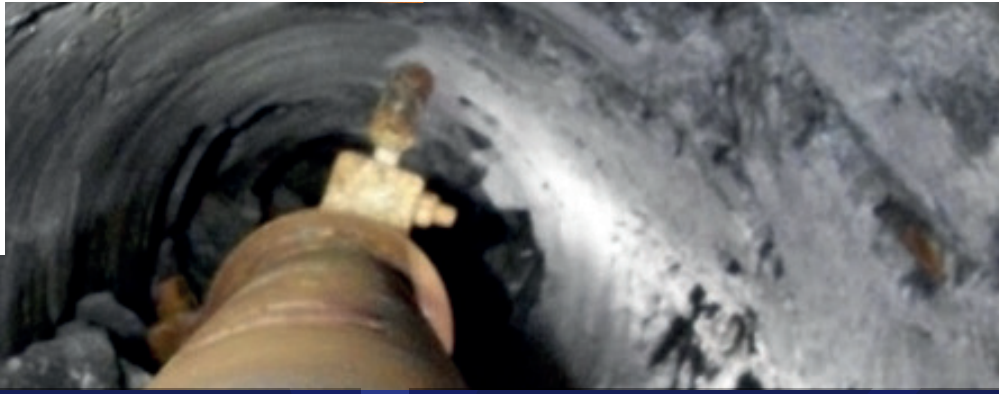
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NON-EXPLOSIVE ROCK BREAKING

“Non-stop production, zero harm, no waste mining”

The goal of the Non-Explosive Rock Breaking programme, one of six programmes of the South African Mining Extraction, Research, Development and Innovation (SAMERDI) strategy, is to identify, develop and support the implementation of solutions that will enable the continuous breaking of rock from tabular, hard-rock orebodies.

The systems that are to be implemented should result in fragmentation of rock that is easily loaded, transported and processed. The system must be incorporated in a layout which maximises extraction by reducing waste mining and reducing or eliminating the need for pillars. The layout, support design and operation of systems must ensure that workers are not exposed to unnecessary rockfall or seismic risk, thereby supporting the industry goal of achieving zero harm. The energy and consumable requirements of the system must be limited to allow for cost-effective implementation of the system.

The research plan for the programme theme under the SAMERDI strategy will seek to support the implementation of systems at experimental sites. This programme is an opportunity to integrate the capacity of all the research

providers in South Africa and direct this force towards a common goal that has never been achieved before. Continuous production with minimal waste mining is not just something that is beneficial, it is now necessary for the continued viability of our mines.

It has the potential to revolutionise how we mine in South Africa, and even beyond our national borders. It has the potential to spark the growth of a local equipment manufacturing industry. It will position the South African mining research community as world leaders in the field. Looking further ahead it may pave the way toward a future where mining can be automated. This will allow mining at even greater depths where workers are not exposed to any significant seismic or fall-of-ground risks.

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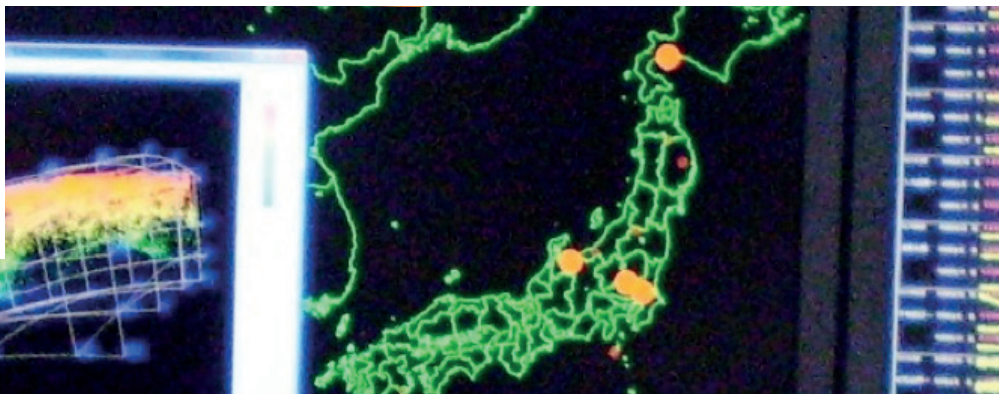
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REAL-TIME INFORMATION MANAGEMENT SYSTEMS

“The right information to the right person all the time”

The Real-Time Information Management Systems programme, one of six programmes of the South African Mining Extraction, Research, Development and Innovation (SAMERDI) strategy, aims to improve data transmission, storage, dissemination, and information management tools, practices, and procedures for mines.

The programme involves the collection, capturing and transferring of information between underground and surface in real-time for smarter decision making, operations and control in order to improve the efficiency and safety of mining operations. The Real-Time Information Management System programme must cater for multiple applications, use cases and scenarios.

There is poor situational awareness underground and it is well understood that smarter decision making and control within the context of smart systems are required for multiple applications utilising shared information, communication and technology infrastructure.

Consequently, Real-Time Information Management Systems are very complex which can force vendor lock-in to ensure interoperability. There are trends around open source software and open standards as well as the Industrial Internet of Things and Cyber Physical Systems that

can be utilised to create interoperable platforms. However, architectures and standards are still evolving and are not at a mature stage. These challenges pose a significant risk to mines adopting any form of real time information management systems, and hence investment in such systems.

To address the need, we want to create or adopt a holistic real time information management system architecture for multipurpose requirements developing (or adopting) common open-source tools and components required to enable these solutions which will fit into an end-to-end Industrial Internet of Things architecture.

Selected applications will be demonstrated to show the efficacy and utility of this common enabling real time information management systems infrastructure. The enabling system infrastructure components and designs will be made available royalty-free to mines and original equipment manufacturers to ensure its wide adoption. Additionally, a local ecosystem of products and services can be built around it. There will be a utility gain for mines and an economic multiplier effect by opening the ecosystem of real time information management systems-based solutions to local original equipment manufacturers.

The objectives of the programme are to:

1. Deploy appropriate real time information management system and control systems in South African mines;
2. Deliver the real time information management system common core of an open source Internet of Things system royalty-free, along with reference designs of nodes and gateways that are secure, manageable and form a stope network with appropriate communications and positioning;
3. Demonstrate the utility to mines with one or two example use cases; and
4. Deliver components at Technology Readiness Level 6 for original equipment manufacturers to take further and rapidly add to point solutions that will be interoperable for mines.

The objectives of the Real-Time Information Management System are as follows:

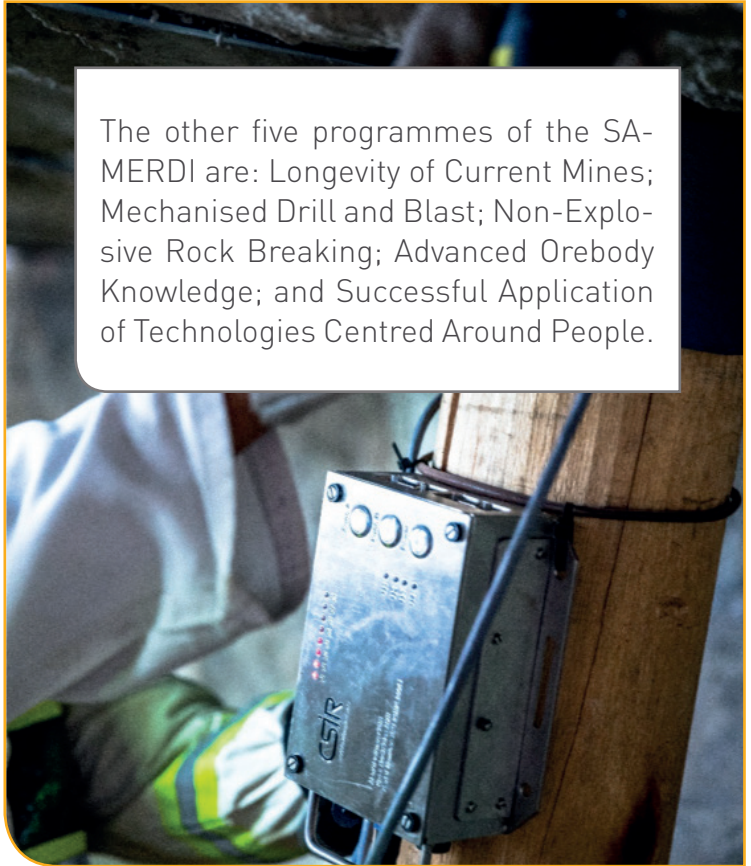
1. Develop the enabling network communications and computing infrastructure for multiple applications and use cases. This includes sensory networks, computing systems, protocols, architectures, etc.; and
2. The development and implementation of selected use cases to show and ensure the required efficacy and utility of the real time information management system infrastructure.

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SUCCESSFUL APPLICATION OF TECHNOLOGIES CENTRED AROUND PEOPLE

“People centred technology and processes”

The Successful Application of Technologies Centred Around People (SATCAP) programme, one of six programmes of the South African Mining Extraction, Research, Development and Innovation (SAMERDI) strategy, places people at the centre of all mining-related activities. This programme serves as an integrating function across all other SAMERDI programmes and has stand-alone deliverables.

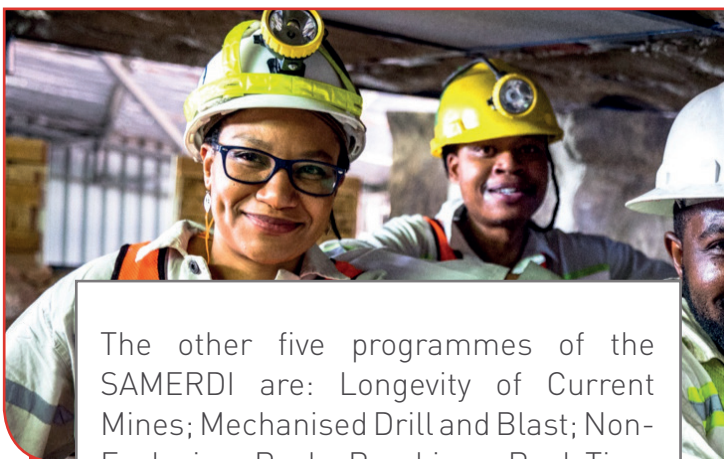
People are at the heart of the SATCAP programme. As the 4th industrial revolution emerges globally, the development and application of technology is inevitable. With the other five research programmes of SAMERDI addressing various aspects of mechanisation and digitalisation, SATCAP seeks firstly to understand how people relate to each other and with technology in this process of modernization.

Currently progressing five streams of research, with operational and strategic thrusts, SATCAP is intended to create platforms for collaboration, cooperation and co-creation amongst all stakeholders in the minerals value-chain. From the boardroom to the mine-face, from government entities to community members, this research programme will allow people to share their perceptions, attitudes, styles of leadership, readiness for change, and the practical aspects of how they interact with emerging technologies.

The SATCAP approach is deeply rooted in two principles: the fundamental dignity and wisdom inherent in every participant in the minerals value chain; and the

understanding that nothing will be done “for us, without us”. This latter right applies to every stakeholder.

Ultimately, SATCAP aims to deliver a people-centered sustainable South African minerals sector, through enabling and sustaining healthy and robust relationships, and collaboratively identifying and pursuing opportunities for change that will deliver on the needs and aspirations of all stakeholders.



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