MODERNISATION AND TECHNICAL INNOVATION FOR JUNIOR MINING COMPANIES

4 NOVEMBER 2021

#TheFuture’sMine
IMPERATIVE OF MODERNISATION

SIETSE VAN DER WOUDE - SENIOR EXECUTIVE, MODERNISATION AND SAFETY, MINERALS COUNCIL SOUTH AFRICA

#TheFuture’sMine
Junior Miners see their greatest purpose as:

- Job creation
- Wealth creation for entrepreneurs who take risks
- To spearhead introduction of new technology in mining
- To utilise mineral resources too small for major mining houses’ overhead structures

**Source:** Junior Mining Research Report, 2019
CRITICAL MINERALS PRESENT OPPORTUNITIES TO BROADEN SOUTH AFRICA’S COMMODITY OFFERING AND STRENGTHEN THE MINING SECTOR

2018 US critical and strategic minerals
35 critical minerals
31 of which imports >50% annual consumption
14 of which 100% import-reliant

2020 EU Critical raw materials
30 critical minerals
Foresighted critical shortage of minerals such as lithium and cobalt for electric vehicle batteries and energy storage

"Secure access to critical minerals through trade and investment with international partners […]"

"Secure access to critical minerals through trade and investment with international partners, while ensuring that foreign trade practices do not harm U.S. industries and broader national interests"

EU action plan for critical raw materials: Diversified sourcing from third countries
"Such strategic partnerships covering extraction, processing and refining are particularly relevant for resource-rich developing countries and regions such as Africa."

Action 9 – Develop strategic international partnerships and associated funding to secure a diversified and sustainable supply of critical raw materials […] starting with pilot partnerships with Canada, interested countries in Africa and the EU’s neighbourhood in 2021 […].

MANY CRITICAL MINERALS PRESENT EXCELLENT OPPORTUNITIES FOR JUNIOR AND EMERGING MINERS IN SA

<table>
<thead>
<tr>
<th>Critical minerals identified by US and/or EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al  Bauxite</td>
</tr>
<tr>
<td>Be  Beryllium</td>
</tr>
<tr>
<td>Cs  Cesium</td>
</tr>
<tr>
<td>Cr  Chromium</td>
</tr>
<tr>
<td>Co  Cobalt</td>
</tr>
<tr>
<td>Ga  Gallium</td>
</tr>
<tr>
<td>Ge  Germanium</td>
</tr>
<tr>
<td>C  Graphite</td>
</tr>
<tr>
<td>He* Helium</td>
</tr>
<tr>
<td>In  Indium</td>
</tr>
<tr>
<td>Li* Lithium</td>
</tr>
<tr>
<td>Mg  Magnesium</td>
</tr>
<tr>
<td>Mn  Manganese</td>
</tr>
<tr>
<td>Nb  Niobium</td>
</tr>
<tr>
<td>Pd  Palladium</td>
</tr>
<tr>
<td>PtPd PGMs</td>
</tr>
<tr>
<td>Re  Rhenium</td>
</tr>
<tr>
<td>Rb  Rubidium</td>
</tr>
<tr>
<td>Ru  Ruthenium</td>
</tr>
<tr>
<td>Sc  Scandium</td>
</tr>
<tr>
<td>Sr  Strontium</td>
</tr>
<tr>
<td>Ta* Tantalum</td>
</tr>
<tr>
<td>Ti* Titanium</td>
</tr>
<tr>
<td>W  Tungsten</td>
</tr>
<tr>
<td>U  Uranium</td>
</tr>
<tr>
<td>V  Vanadium</td>
</tr>
<tr>
<td>Zr  Zirconium</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Critical minerals presence and potential in South Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
</tr>
<tr>
<td>Al  Bauxite</td>
</tr>
<tr>
<td>Be  Beryllium</td>
</tr>
<tr>
<td>Cs  Cesium</td>
</tr>
<tr>
<td>Co  Cobalt</td>
</tr>
<tr>
<td>Ga  Gallium</td>
</tr>
<tr>
<td>Ge  Germanium</td>
</tr>
<tr>
<td>C  Graphite</td>
</tr>
<tr>
<td>He* Helium</td>
</tr>
<tr>
<td>Mn  Manganese</td>
</tr>
<tr>
<td>Pd  Palladium</td>
</tr>
<tr>
<td>PtPd PGMs</td>
</tr>
<tr>
<td>Re  Rhenium</td>
</tr>
<tr>
<td>Rb  Rubidium</td>
</tr>
<tr>
<td>Ru  Ruthenium</td>
</tr>
<tr>
<td>Sc  Scandium</td>
</tr>
<tr>
<td>Sr  Strontium</td>
</tr>
<tr>
<td>Te  Tellurium</td>
</tr>
<tr>
<td>Ti* Titanium</td>
</tr>
<tr>
<td>U  Uranium</td>
</tr>
<tr>
<td>V  Vanadium</td>
</tr>
<tr>
<td>Y  Yttrium</td>
</tr>
<tr>
<td>Zr  Zirconium</td>
</tr>
</tbody>
</table>

Key:
- Dormant mines / renewed interest
- By-product of or occurrence in widely mined mineral
- Mined mineral
- Occurrences
- Many occurrences
- High potential / being developed
INNOVATION NEEDS MINING…

SCREEN ➔ ELECTRONICS

TOUCH: INDIUM TIN OXIDE

GLASS: ALUMINA AND SILICA

COLOURS: RARE EARTH METALS

BATTERY ➔ CASING

THE SILICON CHIP

CONNECTING ELECTRONICS

WIRING & MICROELECTRONICS

MICROPHONES & VIBRATIONS

Key:
- <1% recycle rate
- <1-10% recycle rate
- <10-25% recycle rate
- <25-50% recycle rate
- <50% recycle rate
- Non-metal (or recycle rate unknown)
MINING NEEDS INNOVATION

Over last decade, mining productivity decreased by 7.6%.

Costs rose by 2-3% in real terms.

Two-thirds of SA's mining output in upper half of global mining cost curve.
IMPROVED ESG IS LINKED TO GLOBAL COMPETITIVENESS…

Companies with higher ESG ratings (from MSCI) had an average total shareholder return of 34% over the past 3 years – 10% higher than the general market index.

PwC, 2021
...AND INNOVATION HAS A DIRECT LINK TO IMPROVED ESG PERFORMANCE

Total Harm Indicator rate per 1000

<table>
<thead>
<tr>
<th>Year</th>
<th>THI rate per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>24.55</td>
</tr>
<tr>
<td>2008</td>
<td>23.76</td>
</tr>
<tr>
<td>2009</td>
<td>22.87</td>
</tr>
<tr>
<td>2010</td>
<td>21.99</td>
</tr>
<tr>
<td>2011</td>
<td>17.51</td>
</tr>
<tr>
<td>2012</td>
<td>16.81</td>
</tr>
<tr>
<td>2013</td>
<td>18.89</td>
</tr>
<tr>
<td>2014</td>
<td>19.30</td>
</tr>
<tr>
<td>2015</td>
<td>21.11</td>
</tr>
<tr>
<td>2016</td>
<td>18.18</td>
</tr>
<tr>
<td>2017</td>
<td>15.34</td>
</tr>
<tr>
<td>2018</td>
<td>12.34</td>
</tr>
<tr>
<td>2019</td>
<td>12.10</td>
</tr>
</tbody>
</table>
INNOVATION IN SA MUST BE ‘PEOPLE-CENTRIC’, NOT TECH-CENTRIC

Zero Harm

Environmental sustainability

Included, thriving communities

Economic development and saved livelihoods
COVID-19 SLOWED THE WORLD, BUT ACCELERATED CHANGE

Before Multiple queues

- Manual admin processes
  - Manual blocking of cards
  - Incorrect information on the form
- Systems not integrated
- Separate work stations
- Long queues
- Inadequate resources

Phase 2 One Stop Station

- Combined stations
- IT infrastructure support
- Secure resources
- Effective communication

Phase 3 Smart Station

- Engage app
- HealthSource tablet set up
- System integration
- Training & deployment

Phase 4 e-screening

- Trial of Phase 2 app release
- We Care e-permit solution
- Awareness campaign
- Training & deployment

The Kumba Iron Ore example (2020)
THE MINERALS COUNCIL’S APPROACH TO PEOPLE-CENTRIC MODERNISATION

**Strategy**

People-centric, 4IR-enabled Modernisation Strategy

**Ecosystem**

Credible mining ecosystem facilitators (PPP)

Innovation Infrastructure e.g. Test Mine, Mining Tech Incubation

**Resources**

**Human Resources:** Accelerated, transformative innovation capacity-building programme

**Financial resources:** Multi-source, significant innovation investment

**Technology resources:** Technology-related tools to enable implementation of the Modernisation strategy
TO ACHIEVE THIS, THE COUNCIL DRIVES A NUMBER OF MODERNISATION-FOCUSED PROJECTS

Minerals Council SA
Modernisation projects portfolio

Implementing partner

RIIS

• Modernisation Focused Strategy
• Mining Skills 4.0
• Mpumalanga CoalfIELDS 2030+
• Data 4.0

Mandela Mining Precinct

• Longevity of current mines
• Mechanised Mining Systems
• Real Time Information Management Systems
• Advanced Orebody Knowledge
• Successful Application of Technology Centred around People
• Test Mine
THE MANDELA MINING PRECINCT VISION FOR THE JUNIOR AND EMERGING MINER SECTOR

DICK KRUGER – STRATEGIC TECHNICAL ADVISOR, MANDELA MINING PRECINCT

#TheFuture’sMine
MODERNISATION AND JUNIOR MINING

- Junior mining is not artisanal mining
- Junior mining is not primitive
- A junior mining operation can be modern and mechanised
- Mandela Mining Precinct is relevant for Junior Miners
MANDELA MINING PRECINCT: MINDS FOR MINES

2014
SAMERDI Strategy Formulated

2015
Adopted by Mining Phakisa

2016
Mandela Mining Precinct as implementation agency

Hub & Spoke model
Hub: Mandela Mining Precinct
Spokes: Research partners

Direction and funding
provided to research partners
A MULTI-STAKEHOLDER GOVERNANCE AND OVERSIGHT STRUCTURE

SAMESDI STEERING COMMITTEE

Departments:
- Mineral Resources and Energy
- Science and Innovation
- Trade, Industry and Commerce

EXECUTIVE COMMITTEE

Independent member

MINERALS COUNCIL SOUTH AFRICA

CSIR

MEMSA

M INERALS COUNCIL SOUTH AFRICA

Director

Strategic advisor

MINERALS COUNCIL SOUTH AFRICA

CSIR

MEMSA

M INERALS COUNCIL SOUTH AFRICA

Director

Strategic advisor
STAFFING

01 Director
01 Strategic advisor
05 Programme managers
03 Support staff
08 Interns
PROGRAMMES

SUCCESSFUL APPLICATION OF TECHNOLOGIES CENTRED AROUND PEOPLE (SATCAP)

MECHANISED MINING SYSTEMS

ADVANCED OREBODY KNOWLEDGE

REAL-TIME INFORMATION MANAGEMENT SYSTEMS (RTIMS)

LONGEVITY OF CURRENT MINES (LOCM)

TEST MINE
E-Digital skills training for artisans/engineering overseers
E-digital literacy training – enhancing Adult Education and Training
VR Training module to enable miners upskilling
Training simulation for rock drill operators upskilling
MECHANISED MINING SYSTEMS

- Pillar design at depth
- Effective ventilation control system
- Improve blasting frequency
- Equipment utilization and performance monitoring
- Technology for rapid development
ADVANCED OREBODY KNOWLEDGE

- Improved diamond drilling
- Integration of scanning technologies
- Statistical analysis for pothole prediction
REAL TIME INFORMATION MANAGEMENT SYSTEMS (RTIMS)

- Develop the capability for dealing with and leveraging modern/hyper technologies, big data, digital transformation and expediting the digitalisation on-boarding journey
- Develop a shared open data analytics platform for industry
- Develop a network of service and solution providers for 4IR technologies
- Implement and open a RTIMS knowledge base for technical, information management
LONGEVITY OF CURRENT MINES (LOCM)

- Water usage in mining operations
- Energy usage in mining operations
- Remotely controlled scraping with proximity detection
- Identification of leading practices and the dissemination of these
ESTABLISHMENT OF AN UNDERGROUND TEST FACILITY UNDERWAY

- Feasibility study with risk and legal framework
- Discussions with inspectorate confirmed support
- Low risk testing already taking place
- Workshop CONFIRMED INDUSTRY SUPPORT
OUTPUTS: GUIDELINES

Technical services optimisation:
Guidelines for pillars

Guideline: Ventilation engineering

Energy efficiency:
Guideline for the mining sector

Guideline for best practice applications of mechanised equipment

Guideline: Shaft infrastructure and access development
OUTPUTS: GUIDELINES

- Lightweight synthetic support elongate
- Two lightweight hydro rockdrill prototypes
DIGITAL APPLICATIONS IN MINING FOR JUNIOR AND EMERGING MINERS

DAVIS COOK – CEO, RIIS
ALEXANDRA LUGAGE – MANAGER, RIIS

#TheFuture’sMine
New technologies are dramatically changing the cost structures for businesses
Space-based platforms are providing dramatic cost reductions in remote sensing for exploration

**Satellite imagery cost accessibility**

Satellite imagery for initial identification
- 30m accuracy
- ASTER / Landsat / Sentinel 2
- **FREE**

More accurate digital elevation models to identify drilling areas
- 2m accuracy
- e.g. DEMSA 2
- e.g. R25-70/km2

**At the cutting edge: Muography**

1. **COSMIC RAY MUONS**
   Muons travel in straight lines from cosmic rays colliding with matter in the Earth’s upper atmosphere

2. **MUON FLUX**
   Muons are slowed down as they enter the Earth’s surface, as they encounter material at different densities

3. **DETECTORS**
   Sub-surface detectors in the survey area measure muon intensity, creating a 60° field of view

4. **SATELLITE TO CLOUD**
   The data captured by the detectors is transmitted to the surface, then via satellite to the Ideon cloud

5. **RADIOGRAPHIC IMAGES**
   The data is transformed into x-ray-like images of density anomalies in the survey area

6. **3D SUBSURFACE MODEL**
   Inversion technologies create sub-surface 3D density delivered into client software tools

Graphic source: Ideon Technologies, [www.ideon.ai](http://www.ideon.ai)
AI is capable of re-analysing existing data sets to discover previously missed orebodies.

"Exploration from a desktop, rather than with a drill rig, has unearthed almost 600 potential deposits of sought-after new economy minerals across Queensland… including 6 possible rare earth systems".

5 top Artificial Intelligence startups* impacting mining exploration

(StartUS Insights, 2020)

*Out of 88 analysed
Work undertaken by the Minerals Council and Mandela Mining Precinct aims to support development and roll out of such technologies
We will delve into a few of the initiatives underway.

Minerals Council SA
Modernisation projects portfolio

Implementing partner

RIIS

Projects
- Modernisation Focused Strategy
- Mining Skills 4.0
- Mpumalanga Coalfields 2030+
- Data 4.0

Mandela Mining Precinct

Projects
- Longevity of current mines
- Mechanised Mining Systems
- Real Time Information Management Systems
- Advanced Orebody Knowledge
- Successful Application of Technology Centred around People
- Test Mine
Through identifying, piloting and testing emerging technologies
Through the RTIMS* programme, underground communications technologies and mechanisms are being piloted and tested.

Integrated stope-communications system: successful application of Coded Orthogonal Frequency Division Multiplexing (COFDM)

Potential applications:

- Improve and ensure communication in
  - Proto team rescues
  - Infrastructure-poor areas
Under Mining Skills 4.0, EdTech solutions to improve training effectiveness and efficiency were sought and demo’ed.

**4IR technologies**

<table>
<thead>
<tr>
<th>Virtual and Augmented Reality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile technology</td>
</tr>
</tbody>
</table>

Combined with innovative approaches to learning:

- Micro-learning
- Gamification
- Human-Centred Design
The Isidingo Drill Design Challenge led to prototyping of handheld rockdrills for faster, safer and more efficient drilling.

**Isidingo Drill Design Challenge**
- Ran from 2018 – 2019
- Two South-African developed designs prototyped and in testing

**Characteristics of drills designed**
- **16 kg** (half of 28-32kg of traditional rock drills)
- Reduced noise and vibration
- Systems to enable easier **accurate, parallel drilling**

2 proudly South African OEMs won with their designs.
The Data 4.0 programme is leveraging geographically coded data for industry monitoring and decision-making.

COVID-19: mine case surveillance and geographical distribution, employee breakdown, vaccination sites mapping

Mapping adoption of MOSH Leading Practices
The work also aims to establish the right mechanisms to enable modernisation and digital transformation by....
…Fostering an enabling environment for innovation
Developing the innovation ecosystem through Open Innovation Programmes

Open Market
Many companies are exploring opportunities in a certain space; neither organisation nor the private sector are aware of each others’ activities.

OI Challenge
An Open Innovation process facilitated the introduction of the organisation to potential industry entrants.

Validation
A structured support process assists entrants to validate their ideas – and hence discard non-viable options.

Pitching
New ventures pitch their ideas through a World Café to potential investors, customers and stakeholders.

Support
Winners are trained and incubated by the implementing partners, to allow them to successfully start their own business.

2018 | Isidingo Drill Design Challenge
- Two locally-designed and locally-made rockdrills

2021 | Reimagining Training in Mining Innovation programme
- 6 South African EdTech innovations

2021 | Mandela Mining Precinct partnership with LEO Open Innovation platform globally
- Open Innovation Challenges for Mining Companies at no cost

Global audience
- 30% Americas
- 30% Europe
- 30% Asia Pacific
- 10% ROW

Cost-saving
- Up to 90% reduced time and cost in finding relevant innovations
...Supporting companies in their modernisation journey
The Mining Skills 4.0 programme has initiated mapping skills transitions from conventional to modernised scenarios based on new technology.
RTIMS’ digital business case validation tools provide support to CIOs and heads of innovation in the Digital Transformation journey

**PROCESS**

- Digital Mandate and focus area
- Digital value drivers and criteria
- Capture: Business information
- Capture: Digital initiatives and information

**Report: Initiative level analysis**

**Report: Detailed portfolio level analysis**

- Capture: Initiative stage gate status
- Report: Executive portfolio level analysis
- Report: Initiative verifiable measures
In addition, the RTIMS knowledge portals enable easy access and adoption of tools, best practices and guidelines

Portals available:

- **RTIMS wiki**: Technical reports repository
  - Contains all research and technical specifications from the 4 years of RTIMS research
- **RTIMS blueprint (Enterprise Architecture)**
  - Allows design of systems, processes, relationships, gaps, optimisation, information and data needs and flows, technology needs, roles and functions.
  - Houses the RTIMS IIOT Framework for Mining

Case study:

**Drill & Blast**: Identified inefficient flow of information such as duplication of daily reports by various functions, potential gaps in processes, and technology needs.

**Freely accessible upon user registration.**
RTIMS Data platform that will be open to industry: Multiple formats, types and sources of data for collation and insights development

Allows implementation at site, company or industry level

Provides interoperability (across OEMs and their products, sensors, software etc)

Value add for Junior and Emerging Miners

Access to data and systems at low to no cost

No need to develop and implement own systems

Enables the digital worker
How can the Junior and Emerging Miners benefit from and help inform these initiatives?
Get involved

Mandela Mining Precinct (RTIMS)
- Map your Digital Transformation Journeys (Strategy and Tactical)
- Access capacity building
- Access data
- Run Open Innovation Challenges

Jean-Jacques Verhaeghe
Programme Manager

Minerals Council Modernisation initiatives
- Pilot solutions
- Leverage industry-level insights and data
- Help steer the modernisation agenda

Sietske van der Woude
Senior Executive: Modernisation and Safety

Davis Cook
RIIS: Modernisation Programme Director
Thank you

T +27 11 498 7100    E info@mineralscouncil.org.za    W www.mineralscouncil.org.za
5 Hollard Street, Johannesburg, 2001, PO Box 61809, Marshalltown 2107