MINERALS COUNCIL
SOUTH AFRICA

MANDELA MINING PRECINCT
MINDS FOR MINES

MODERNISATION AND TECHNICAL INNOVATION FOR JUNIOR MINING COMPANIES

4 NOVEMBER 2021

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SOUTH AFRICA

MANDELA MINING PRECINCT
MINDS FOR MINES

IMPERATIVE OF MODERNISATION

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

#TheFuture'sMine

JUNIOR AND EMERGING MINERS PURPOSE

Junior Miners see their greatest purpose as:

Job creation

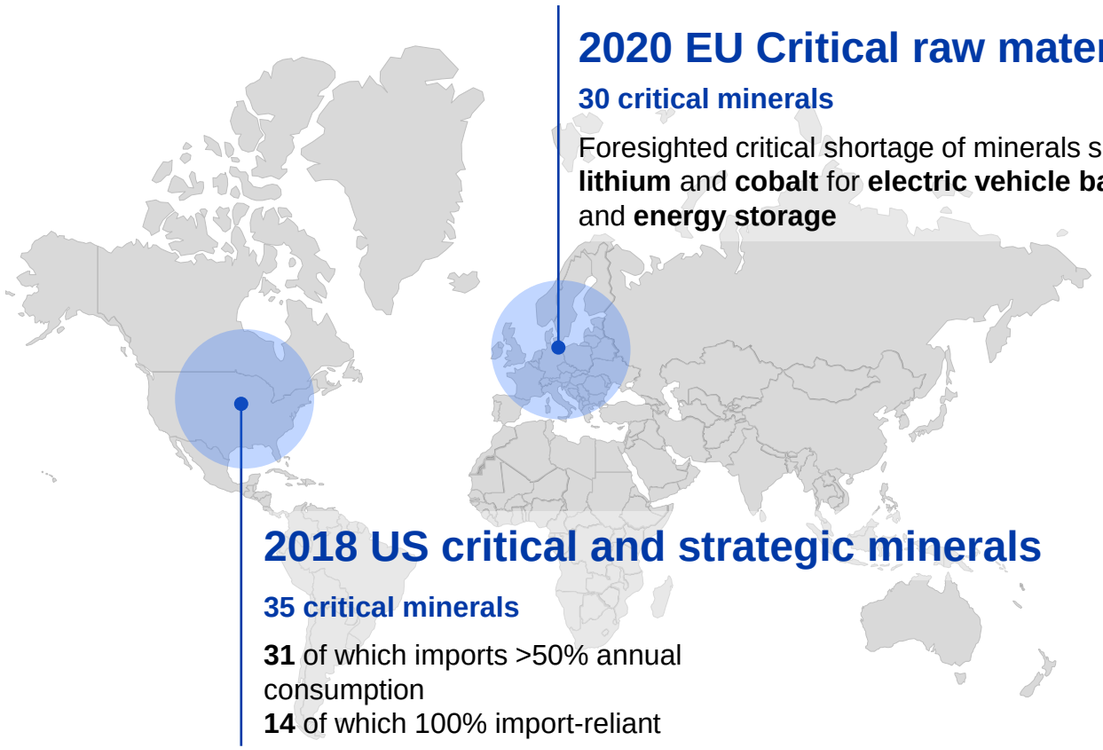
Wealth creation for entrepreneurs who take risks

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



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**

2018 US critical and strategic minerals

35 critical minerals

31 of which imports >50% annual consumption
14 of which 100% import-reliant

US Federal strategy:
Enhance International Trade and Cooperation related to Critical Minerals

"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 […].

Sources: US Government (2019) A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals; European Commission (2020) Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability

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

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Critical minerals identified by US and/or EU

Aerospace

Al Bauxite	Be Beryllium	Cs Cesium	Cr Chromium	Co Cobalt	Ga Gallium	Ge Germanium	C Graphite	He ★ Helium	In Indium	Li ★ Lithium	Mg Magnesium	Mn Manganese	Nb Niobium
Pd Palladium	PtPd PGMs	Rare Earths Elements	Re Rhenium	Rb Rubidium	Ru Ruthenium	Sc Scandium	Sr Strontium	Ta ★ Tantalum	Ti ★ Titanium	W Tungsten	U Uranium	V Vanadium	Zr Zirconium

Telecoms and electronics

Sb Antimony	As Arsenic	Ba Barite	Al Bauxite	Bi Bismuth	Cs Cesium	Cr Chromium	Co Cobalt	F ★ Fluorspar	Ga Gallium	Ge Germanium	C Graphite	Au Gold	Hf Hafnium
He ★ Helium	In Indium	Li ★ Lithium	Mg Magnesium	Mn Manganese	Nb Niobium	Pd Palladium	PtPd PGMs	K Potash	Rare Earths Elements	Re Rhenium	Rb Rubidium	Ru Ruthenium	Sc Scandium
Ag Silver	Sr Strontium	Ta ★ Tantalum	Te Tellurium	Ti ★ Titanium	U Uranium	W Tungsten	V Vanadium	Y Yttrium	Zr Zirconium				

Critical to climate change control, RE, Carbon Capture, EVs

Al Bauxite	Cd Cadmium	Cr Chromium	Co Cobalt	Cu Copper	Dy Dysprosium	Ga Gallium	In Indium	Fe Iron	Li ★ Lithium
Mg Magnesium	Mn Manganese	Mo Molybdenum	Ni Nickel	Nd Neodymium	Se Selenium	Si Silicon metal	Ag Silver	Zn Zinc	

Critical minerals presence and potential in South Africa

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…

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SCREEN

TOUCH: INDIUM TIN OXIDE

In Indium | Sn Tin | O Oxygen

GLASS: ALUMINA AND SILICA

Al Aluminium | Si Silicon | O Oxygen | K Potassium

COLOURS: RARE EARTH METALS

Y Yttrium | La Lanthanum | Tb Terbium | Pr Praseodymium

Eu Europim | Dy Dysprosium | Gd Gadolinium

ELECTRONICS

WIRING & MICROELECTRONICS

Cu Copper | Ag Silver | Au Gold | Ta Tantalum

MICROPHONES & VIBRATIONS

Ni Nickel | Dy Dysprosium | Pr Praseodymium | Tb Terbium | Nd Neodymium | Gd Gadolinium

THE SILICON CHIP

Si Silicon | O Oxygen | Sb Antimony | As Arsenic | P Phosphorus | Ga Gallium

CONNECTING ELECTRONICS

Sn Tin | Pb Lead

BATTERY

Li Lithium | C Carbon | Co Cobalt | Al Aluminium | O Oxygen

CASING

C Carbon | Mg Magnesium | Br Bromine | Ni Nickel

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

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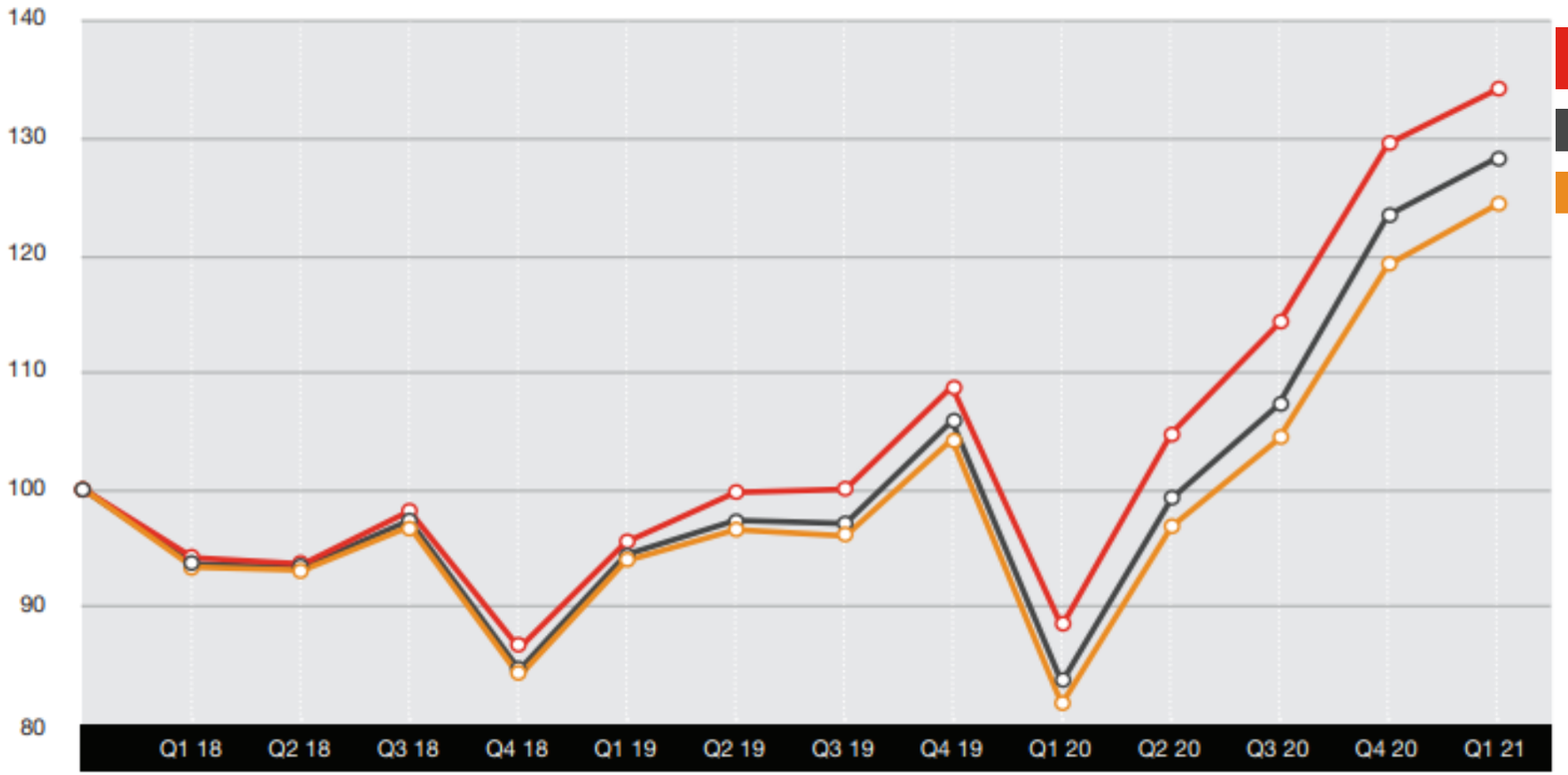
Over last decade mining productivity **decreased by 7.6%**

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…



Source: S&P Capital IQ, MSCI

Note: Morgan Stanley Capital Index (MSCI)'s All Country World Index (ACWI) ESG Leaders Index includes companies with high ESG ratings in developed and emerging markets. The ACWI SRI Index comprises mainly the same companies but excludes those with products that have a negative social or environmental impact.

Companies with ESG focus, excluding those with products that have negative social / environmental impact

All companies with strong ESG focus

Standard companies, without ESG focus

> 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

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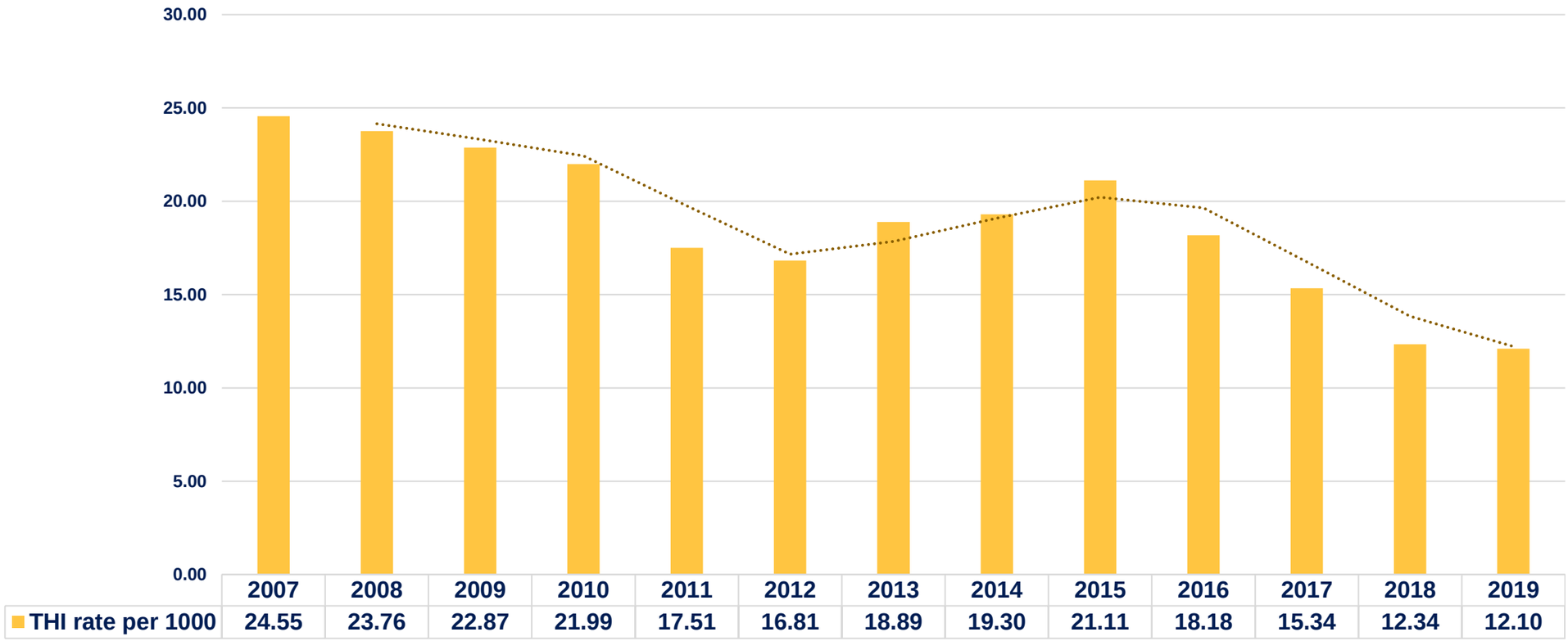
Total Harm Indicator rate per 1000



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
THI rate per 1000	24.55	23.76	22.87	21.99	17.51	16.81	18.89	19.30	21.11	18.18	15.34	12.34	12.10

INNOVATION IN SA MUST BE ‘PEOPLE-CENTRIC’, NOT TECH-CENTRIC

COVID-19 SLOWED THE WORLD, BUT ACCELERATED CHANGE

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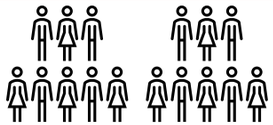
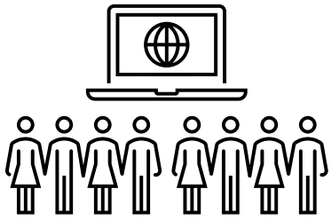
4 hours → 1 hour → 45 min → 20 min



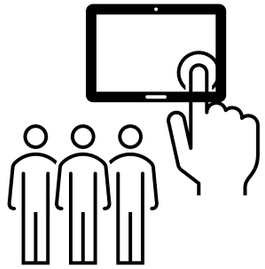
Before
Multiple queues

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



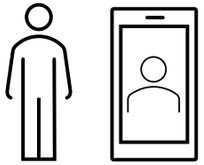
Phase 2
One Stop Station

- 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

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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**	**Mandela Mining Precinct**
Projects	• Modernisation Focused Strategy • Mining Skills 4.0 • Mpumalanga Coalfields 2030+ • Data 4.0	• Longevity of current mines • Mechanised Mining Systems • Real Time Information Management Systems • Advanced Orebody Knowledge • Successful Application of Technology Centred around People • Test Mine

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MANDELA MINING PRECINCT
MINDS FOR MINES

THE MANDELA MINING PRECINCT VISION FOR THE JUNIOR AND EMERGING MINER SECTOR

DICK KRUGER – STRATEGIC TECHNICAL ADVISOR, MANDELA MINING PRECINCT

MODERNISATION AND JUNIOR MINING

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MINDS FOR MINES

- 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

MANDELA MINING PRECINCT
MINDS FOR MINES

2014

SAMERDI Strategy Formulated

2015

Adopted by Mining Phakisa

2016

Mandela Mining Precinct as implementation agency

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science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

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

Direction and funding
provided to research partners

A MULTI-STAKEHOLDER GOVERNANCE AND OVERSIGHT STRUCTURE

MANDELA MINING PRECINCT
MINDS FOR MINES

SAMERDI STEERING COMMITTEE

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

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CSIR
Touching lives through innovation

MEMSA
MINING EQUIPMENT MANUFACTURERS OF SOUTH AFRICA

Independent member

EXECUTIVE COMMITTEE

MINERALS COUNCIL SOUTH AFRICA

CSIR
Touching lives through innovation

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Director

Strategic advisor

STAFFING

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

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PROGRAMMES

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SATCAP

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- 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

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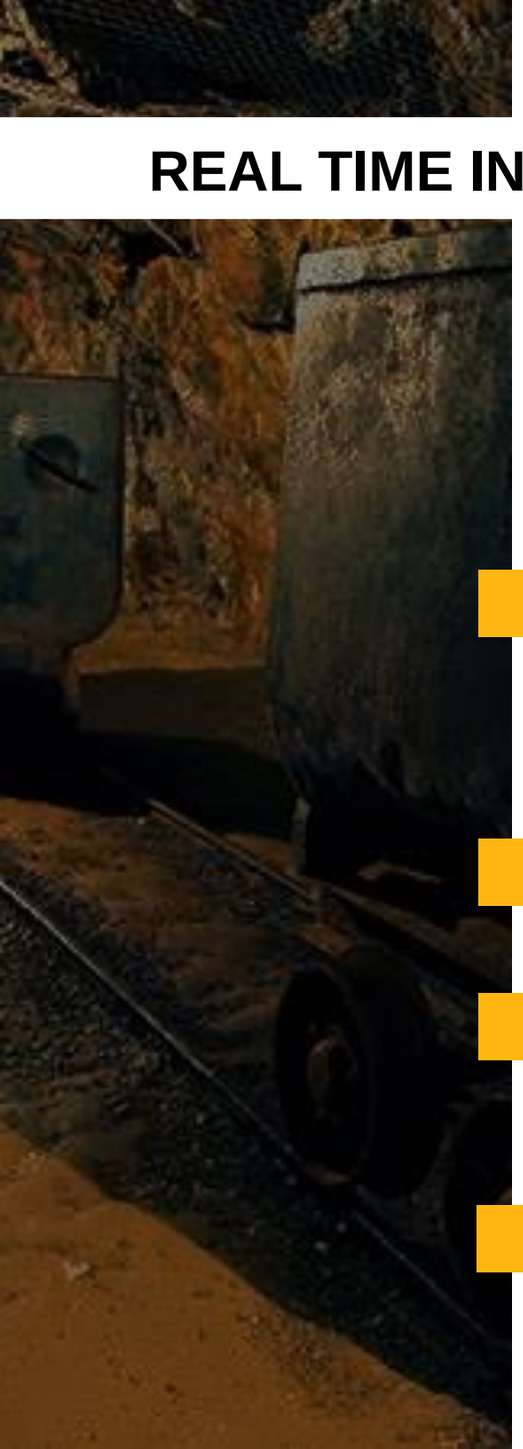
- Improved diamond drilling
- Integration of scanning technologies
- Statistical analysis for pothole prediction



REAL TIME INFORMATION MANAGEMENT SYSTEMS (RTIMS)

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- **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)

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- 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

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

OUTPUTS: GUIDELINES

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Technical services optimisation:
Guidelines for pillars

Guideline: Ventilation engineering

Energy efficiency:
Guideline for the mining sector

Guideline: Shaft infrastructure and access development

Guideline for best practice applications of mechanised equipment

OUTPUTS: GUIDELINES

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- **Lightweight synthetic support elongate**
- **Two lightweight hydro rockdrill prototypes**

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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

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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 of different densities

3. DETECTORS

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

4. SATELLITE TO CLOUD

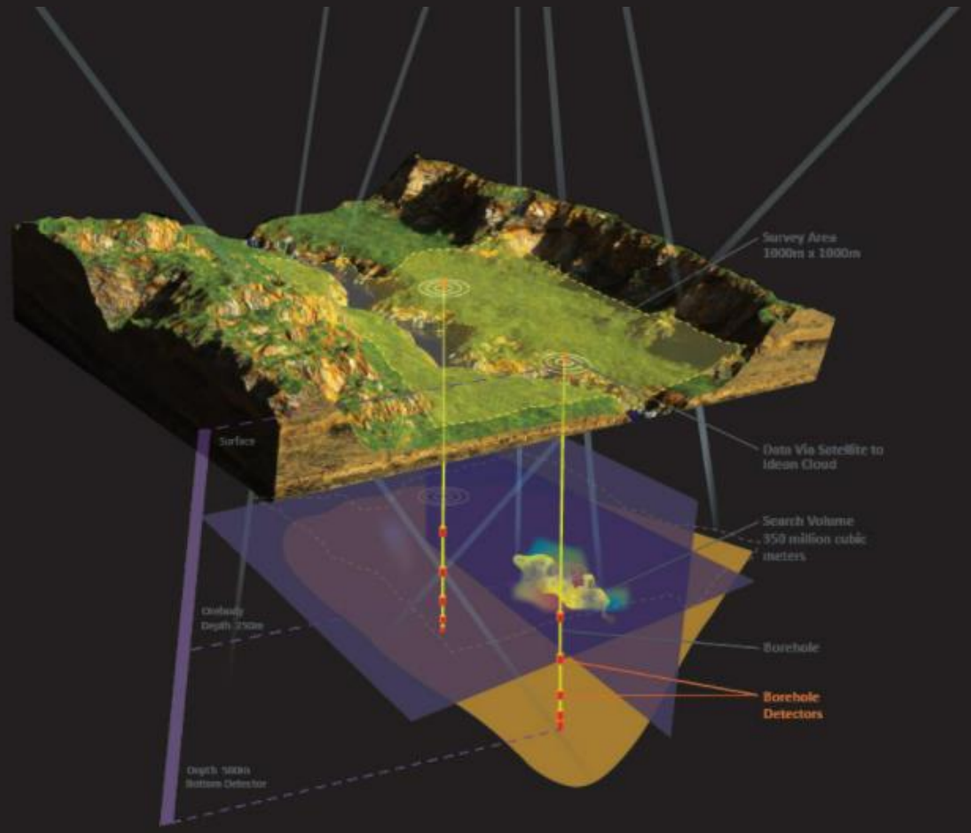
The data captured by the detectors is transmitted to the surface, then via satellite to the Ideon cloud

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 subsurface 3D density delivered into client software tools



Graphic source: Ideon Technologies, www.ideon.ai

AI is capable of re-analysing existing data sets to discover previously missed orebodies

MINERVA INTELLIGENCE

aganitha cognitive solutions

DATAROCK

EARTH AI

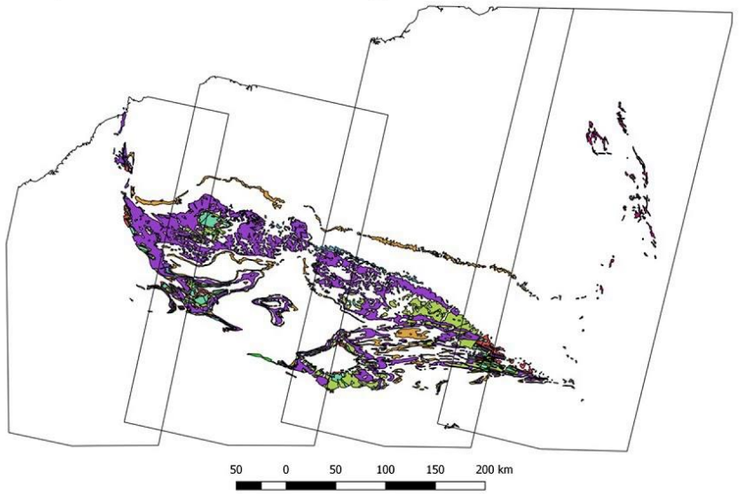
OREFOX

5 top Artificial Intelligence startups* impacting mining exploration

(StartUS Insights, 2020)

**Out of 88 analysed*

Searching for surface signatures in the Pilbara using Supervised Learning



- Total model area 262,704 km²
- 300,000,000 data points
- 11-15 layers of data

- 10 Landsat 8 OLI scenes
- SRTM
- Regional radiometrics
- Regional aeromagnetic data

AURORA MINERALS GROUP

www.solvegeosolutions.com

"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".

Australian Minister for Resources. Scott Stewart
October 2021

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

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MINDS FOR MINES

Minerals Council SA

Modernisation projects portfolio

Implementing partner	**RIIS**	**Mandela Mining Precinct**
Projects	• Modernisation Focused Strategy • Mining Skills 4.0 • Mpumalanga Coalfields 2030+ • Data 4.0	• 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

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MINDS FOR MINES

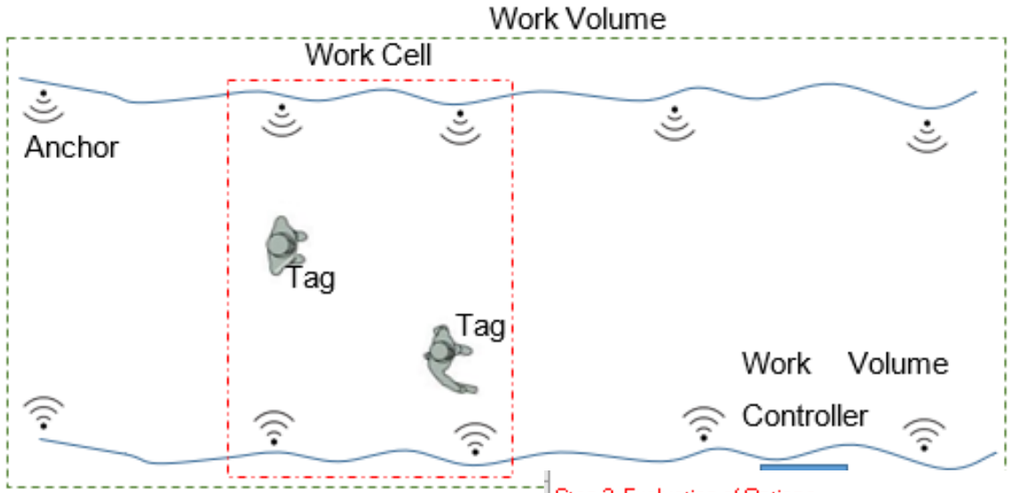

Figure 1) Plan view of the work volu

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**

Step 3: Evaluation of Options

Recommended Technology Options Based on Selections Above	Buisness Considerations		Legislative Compliance	Interoperab
	Applicable to Mining Method	Relevance based on Life of Mine		
Connectivity backbone				
Coaxial power & connectivity	Applicable	Applicable	Compliant	√
VHF (Very high frequency Leaky Feeders)	Applicable	Not Applicable	Compliant	x
UHF (Ultra high frequency Leaky Feeders)	Applicable	Not Applicable	Compliant	x
Connectivity extension (propagation)				
Data Aggregation				

Cover Page | Key Assumptions | **Decision Framework** | Legislature Review | Sheet2

***Real-Time Information Management Systems**

Under Mining Skills 4.0, EdTech solutions to improve training effectiveness and efficiency were sought and demo'ed

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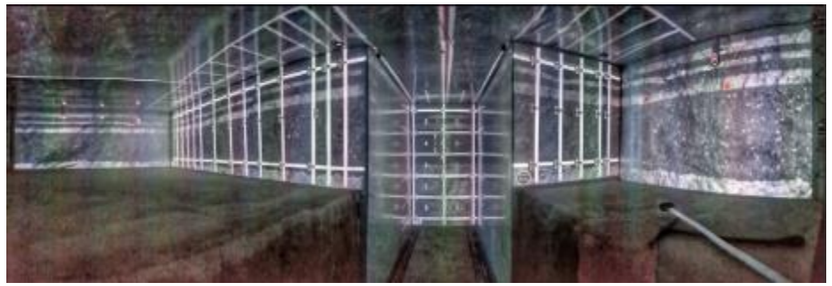
4IR technologies

Virtual and Augmented Reality



Mobile technology

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

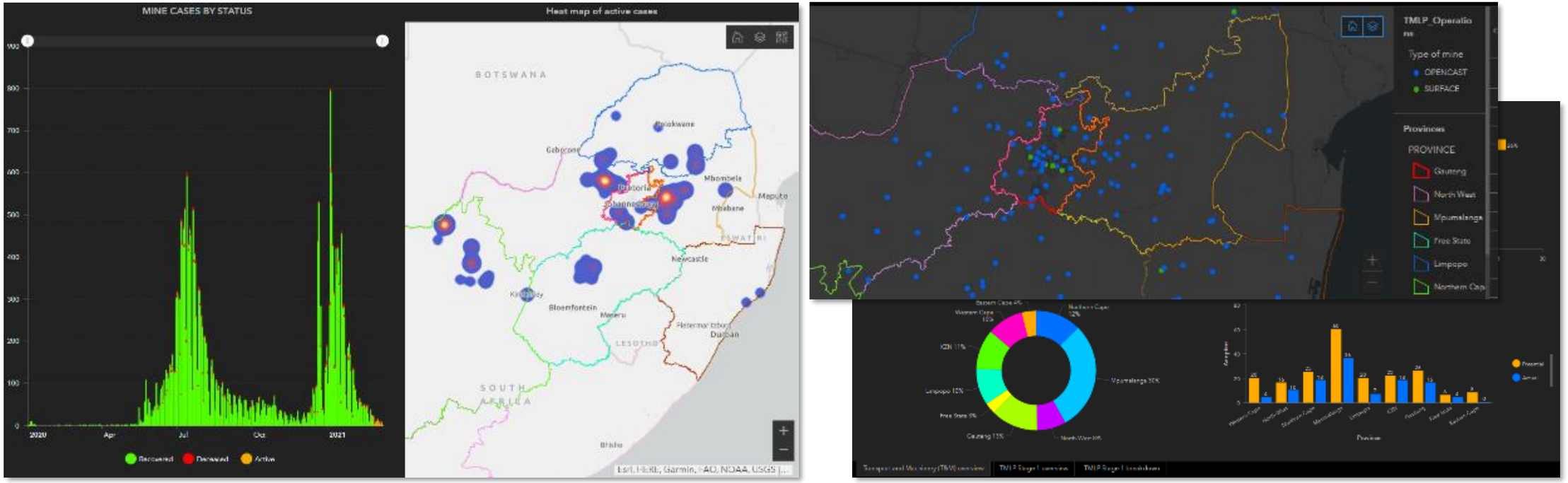
Characteristics of drills designed

- **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

NOVATEK HPE

The Data 4.0 programme is leveraging geographically coded data for industry monitoring and decision-making



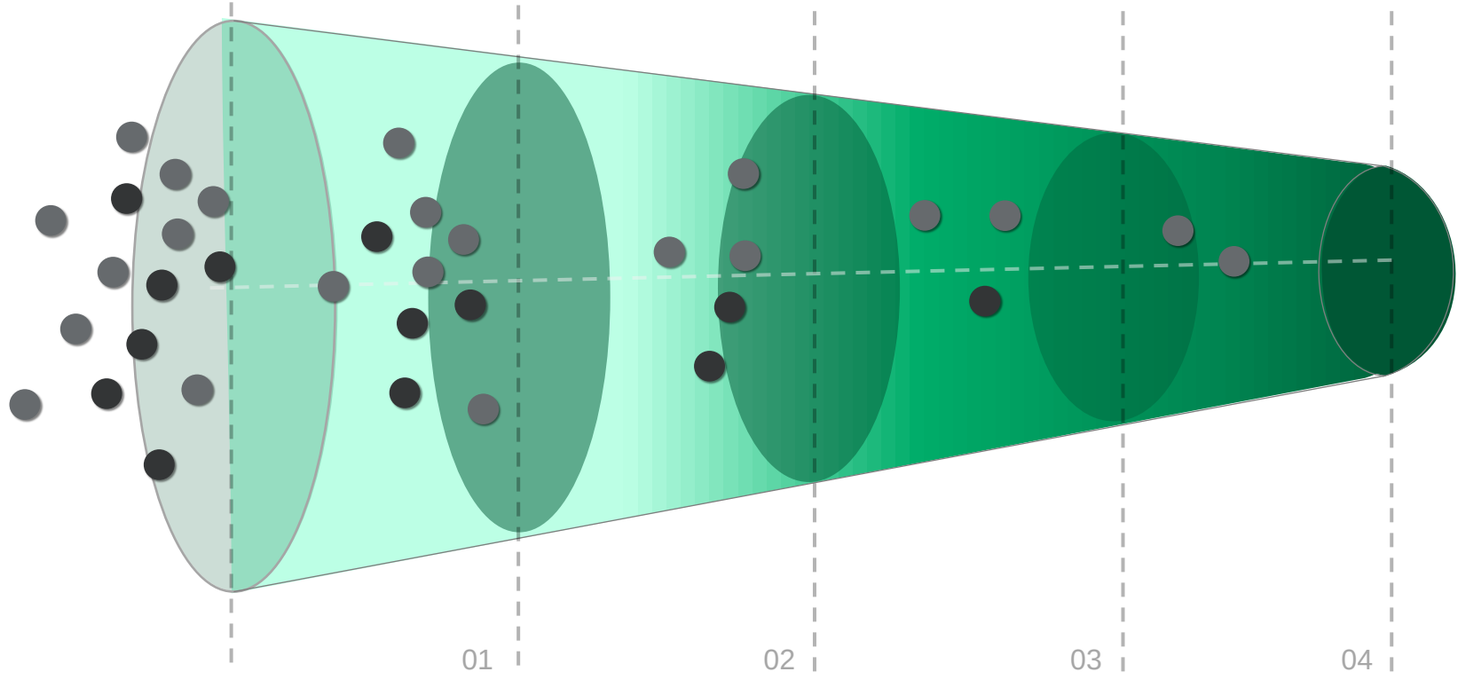
COVID-19: mine case surveillance and geographical distribution, employee breakdown, vaccination sites mapping

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



01	02	03	04
Open Market	**OI Challenge**	**Validation**	**Pitching**	**Support**
Many companies are exploring opportunities in a certain space; neither organisation nor the private sector are aware of each others' activities.	An Open Innovation process facilitated the introduction of the organisation to potential industry entrants	A structured support process assists entrants to validate their ideas – and hence discard non-viable options	New ventures pitch their ideas through a World Café to potential investors, customers and stakeholders	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***

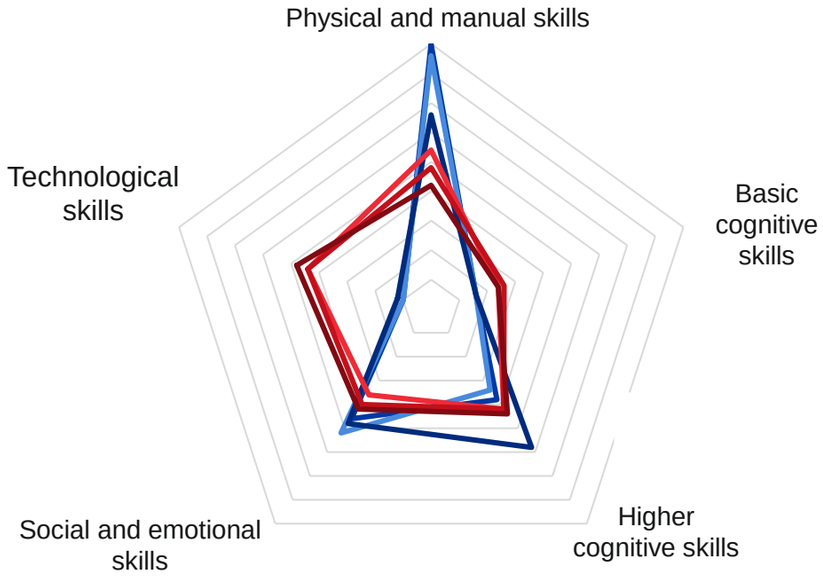
Global audience	**Cost-saving**
30% Americas	Up to **90%** reduced time and cost in finding relevant innovations
30% Europe	
30% Asia Pacific	
10% ROW	

…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

Scenarios

- Conventional RDO *baseline*
- Modernised RDO 1
- Modernised RDO 2
- DRO 1
- DRO 2
- DRO 3



RTIMS' digital business case validation tools provide support to CIOs and heads of innovation in the Digital Transformation journey

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PROCESS

Digital Mandate and focus area

Digital value drivers and criteria

Capture: Business information

Capture: Digital initiatives and information

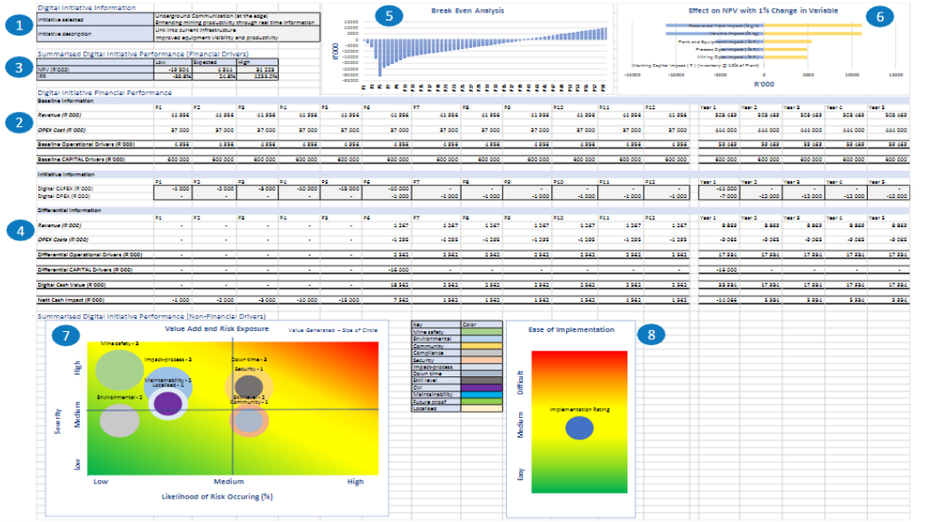
Report: Initiative level analysis

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

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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.

Vision: Entire mining extraction value chain housed on the RTIMS blueprint.

It is only possible with inputs from the industry as the team continues building the components.

Mandela Mining Precinct: Open Data Analytics Platform (ODAP)

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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	**Sietse van der Woude** Senior Executive: Modernisation and Safety **Davis Cook** RIIS: Modernisation Programme Director

Thank you

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