COOi studios

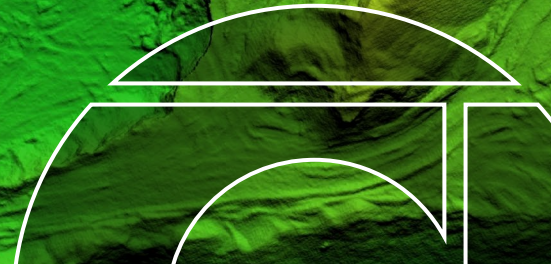# BEYOND TECH TRENDS:

EMBEDDING
INNOVATION
IN MINING
ORGANISATIONS

Contents

Embedding Innovative Solutions in Mining Companies

The shared objective of digital transformation in mining is to improve processes that increase value through innovative end-user experiences that bring about efficiencies that can improve safety and productivity in mining companies.

The advent of the fourth industrial revolution has presented an opportunity for the mining industry, amongst other business imperatives, to improve its cost-effectiveness and future competitiveness. African mining companies manage unique complexities whilst operating in the context of ever-increasing global pressures. They face challenges of profitability, volatile commodity prices, tough regulations, and unstable political environments. These challenges, which often result in high operational costs, have had a negative impact on the mines' profitability and financial sustainability in recent years. Amidst this era of disruption, emerging technologies offer enormous potential in solving some of the business challenges that the African mining sector faces. Despite the enormous potential that digital technologies offer, the rate of adoption across the mining sector has been slow.

The potential of emerging technologies can only be realised if the technologies are adopted. Captured value of digital transformation is dictated by corporate culture and organisational structures.

About the Research

For our point of view, we followed an approach of desktop research, accompanied by a selection of industry case studies and interviews conducted with five innovation and digital managers from mining companies. Our findings pointed to three challenges that are stifling innovation in mining.

These challenges are insufficient funding towards research and development (R&D), misalignment of interests and a shallow talent pool. Additionally, we found that mining companies in corporate ventures work with start-ups that must navigate a challenging entrepreneurial landscape, overcome intellectual property constraints, deal with limited access to funding and a shortage of critical skills. We found that embracing open innovation could potentially benefit mining companies by reducing costs, enhancing agility and offer a diverse talent pool.

The structure of the point of view begins with leading technology trends in the African mining sector. Thereafter, it details the challenges experienced by innovation and digital managers across five aspects of innovation. These aspects being research, corporate venturing, open innovation, building an innovation mindset and scaling innovation.

Leading Technology Trends in the African Mining Sector

In order to remain competitive and ahead of the curve, mining companies have to integrate digitisation into their business operations.

Leading Technology Trends in the African Mining Sector

Mining input costs have generally been rising by 10% and increased to almost 12% near the end of 2021. Simultaneously, profitability margins have been shrinking across the South African mining industry. Considering this, amongst other factors, mining companies have been turning to innovative technologies to run more efficient operations.

In our research we examined five technology trends, a hybrid of emerging and implemented technologies were selected. The implemented technologies are demonstrated by four local case studies. This combination displays the shift from trend to applied technology.

These technologies are:

01
Internet of Things (IoT)

02
Artificial Intelligence (AI)

03
Machine Learning (ML)

04
Digital Twin

05
Metaverse

Internet of Things (IoT)

IoT enables mining organisations to have a network of automated devices that can adjust to environmental conditions in real time. This technology has found numerous applications in the mining industry.
Some of these applications include:

- Geofencing
- Asset tracking
- Remote diagnostics
- Ventilation on demand systems
- Predictive maintenance
- Emission and groundwater level monitoring
- After-blast monitoring

79% of surveyed organisations had implemented IoT technology with 5% expected to implement it within 5 years

- Minerals Council South Africa

IoT offers an opportunity for the mining industry to reduce costs, improve safety and streamline processing.

Case Study: De Beers Marine South Africa deploy geofencing IoT technology

De Beers Marine South Africa installed and tested a customised IoT solution that provided geofencing that enabled safe working distances for employees working around heavy machinery. The solution was piloted on the MV Mafuta, which is currently the world's largest offshore diamond mining vessel.

Artificial Intelligence

AI is the theory and development of computer systems that enable computer programs to perform tasks that normally require human intelligence such as visual perception, speech recognition, decision-making and translation between languages. AI enables mining companies to analyse and respond to possible business disruptions and rapidly identify and address any safety concerns in real time.

Exxaro implemented an AI tool that uses artificial intelligence to provide a three-to-six-month preview of pricing and stock.

Case Study: Rio Tinto's MAS technology

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Another example of AI in the mining sector is found in Rio Tinto MAS technology. MAS stands for Mine Automation System, and it essentially operates like a network server application, pulling together data at 98% of RioTinto's site and mining information. RioTinto then uses AI to make the best use of their system such that they can automatically generate orebody* models, organise equipment dispatch and predict and control blasts. The MAS technology uses sophisticated algorithms to present the data in formats that allow for the data to be visualised in graphs, charts, and tables.

*orebody models are a representation of the geological
and geometric reality of an ore deposit.

Machine Learning

ML is interconnected to AI as it focuses on the development and application of computer systems that can imitate how humans learn and adapt using algorithms and learning techniques such as deep learning. ML enables mining companies to have better insights into areas where humans have natural limitations.

11% of surveyed mining organisations had implemented ML technology, 47% piloted and 21% of respondents planned to implement ML technology within 5 years

- Minerals Council South Africa

Machine learning will continue to be valuable in the mining sector, especially in mineral exploration as ores deplete.

Digital Twin

A digital twin is a digital replica of an object, process or system that can be used for various purposes. It is a virtual representation of a physical object that is meant to be as accurate as possible. Digital twins are utilised in a variety of industries to improve the operational and maintenance of physical assets, systems, and manufacturing processes.

21% of mining companies surveyed by the Minerals Council South Africa had implemented digital twin technology with 47% planning on implementing it within five years.

Digital twin technology allows mining companies to simulate and operate a virtual mine. Mining companies can experiment with parameters and gather insights without harming operations.

Case Study: Digital twin solution at Exxaro's Grootegeluk plant

Digital twin technology has been used at Exxaro's Grootegeluk Coal Complex to track coal materials and model their mixing and movements during the washing phase. A time delay of 12 hours and 50 minutes on average occurs between two coal products. The digital twin technology ensures that performance tracking can be used to evaluate the performance of the process controller.

The metaverse offers great value when it comes to training and onboarding new employees especially in potentially hazardous areas.

Metaverse

The metaverse is a term coined to refer both to current and future integrated digital platforms focused on virtual and augmented reality. In the mining industry it is generally referred to as extended reality (XR) and there is an increasing interest in these immersive technologies for learning and training, visualisation and remote assistance. XR technology includes technologies such as virtual reality (VR), augmented reality (AR) and mixed reality (MR).

11% of surveyed mining organisations had implemented ML technology, 47% piloted and 21% of respondents planned to implement ML technology within 5 years

- Minerals Council South Africa

Case Study: Anglo American Platinum's Amandelbult Training Complex VR Stope

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There is a tremendous amount of pressure on production crews in Platinum Group Metal mines to maximise ore production while reducing mining dilution. An inefficient blast can have severe consequences such as uneven faces, over and overbreaks, shallow advance and falling rocks.
To limit this, Anglo American Platinum embraced digitalisation and turned to innovative and effective methods of training crews. Anglo American Platinum partnered with sts3D and developed the VR Stope and designed it in a manner that could track users in real time within a multi-dimensional stope. The developed software can track up to five people at once and this makes team learning and training possible.

Embedding Innovation: Challenges experienced by Innovation and Digital Mining Managers

Challenges and Opportunities experienced by Innovation and Digital Mining Managers

Various complex hurdles stifle innovation and deaccelerate the rate of adoption of digital transformation technologies in the African mining sector. Innovation and digital mining managers face unique challenges in the process of meeting their strategic innovation objectives. We examined these challenges in three aspects of the innovation process.

These aspects are:

01
Research

02
Corporate Ventures

03
Open Innovation

04
Building an Innovation Mindset and Scaling Innovation.

Driving digital transformation and innovation should be a strategic imperative for mining companies. Innovation and digital Managers cannot champion it in silos.

The role of research in the era of the Innovation buzzword

The allure of the fourth industrial revolution has mesmerised industries and society at large. The concept of the fourth industrial revolution has gained incredible popularity since it was first coined by Klaus Schwab at the World Economic Forum in 2016.

Industries are realising the value and necessity of digital transformation and many businesses are adapting their business strategies to position themselves to be at the forefront of this tide of innovation. Increasingly, businesses are branding themselves to be champions of innovation and are using digital transformation technologies to gain a competitive advantage in a volatile and fiercely competitive global market.

01
Insufficient funding into Research and Development stifles innovation

03
Misalignment of research objectives and interests

03
Limited talent pool

Extracting value from research comes with its unique set of challenges. Some of which are insufficient funding, misalignment of interests and a lack of skilled talent.

Insufficient funding into Research and Development stifles innovation

The Minerals Council South Africa states 25% of surveyed mining organisations invest above0.3% of their turnover in R&D initiatives that concern digital transformation. While 38% and 37% of the companies invest between 0.16% - 0.3% and less than 0.15% respectively. The average investment across all the respondents of the surveycame up to be R111 million.

This is concerning as the total expenditure in R&D in the mining sector has been on a decline. The South African national survey of research and experimental development 2019/2020 statistical report outlines how spending in R&D in the mining sector decreased by 60.7% in 2019/20 from the previous period of 2018/19, down from R1.748 billion to R 686 million.

Standard Industrial Classification
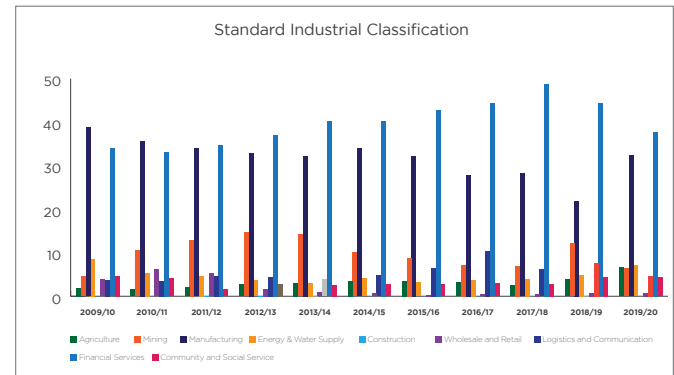
Figure 1 displays the proportional R&D expenditure of various sectors from the period of 2009 to 2020.
With exception of the period of 2009/10, 2016/17 and 2019/20, the South African Mining sector has been the third highest spending sector in research and development, coming third behind only the Manufacturing and Financial Services sectors.

Misalignment of research objectives and interests

There is a misalignment of research objectives when it comes to academia and mining corporates. Mining companies tend to focus on research that seeks to solve specific operational challenges facing their organisation. On the other hand, some members of academia have interests of pursuing exploratory research in the field of digital technologies.

Exxaro's current approach to research is problem statement driven, innovation is aimed at solving specific challenges within operations rather than purely exploratory research.

Consequently, funding earmarked for R&D by the government to academia working in digital transformation may not translate into tangible value for mining organisations.

There needs to be increased synergy and coordination between government, academic and business interests in driving digital transformation in society.

Limited talent pool

Another challenge when it comes to innovative research in digital technologies in the African mining sector is the competition for talent. According to the Department of Higher Education, only 6% of the South African population have university degrees. Their report outlined how the low number of citizens with degrees compromised the country's economic competitiveness. The percentage of graduates specialising in digital technologies in the context of the mining sector is miniscule.

Different sectors compete for the brightest talent, and this limits the potential of development of digital transformation within the mining industry.

Case Study: Exxaro partnership with University of Pretoria

In 2021, Exxaro announced its partnership with the University of Pretoria to establish the first ever Exxaro Chair in Extended Reality (XR) Technology. Exxaro stated that they have a large team at the University of Pretoria that includes developers and researchers working on projects that are of high priority to Exxaro's objectives. This large team works on various projects for Exxaro including proof of concepts and present the outcomes of their research to Exxaro. The partnership is relatively new, but Exxaro is hopeful that they will see some tangible results from it early into 2023.

Case Study: Sibanye-Stillwater Digital Mining (DigiMine) Laboratory at Wits University

The Sibanye-Stillwater Digital Mining Laboratory (DigiMine) is a state of the art and one of a kind laboratory. The aim of the laboratory is to make mining safer and more sustainable using digital technologies. These technologies will enable a mine's control system to autonomously observe, evaluate and act, including moving towards real-time responses. A team of highly skilled researchers at DigiMine conduct tests, research and development, and seek innovative solutions, transferring surface digital technologies into the underground mining environment. The research conducted at DigiMine involves deep partnerships with commercial, academic and industry entities.

Sibanye-Stillwater stated that traditionally, the mining sector had adopted mechanical solutions designed by a narrow and specific skill set to solve challenges and that approach made sense decades ago. However, in the era of the 4th industrial revolution and moving into the 5th industrial revolution the need for a multi-disciplinary approach to problem solving is both necessary and incredibly value adding.

Mining Companies in Corporate Venturing

Mining Companies in Corporate Venturing

Corporate venturing refers to when one company provides venture capital for another company as part of a plan to partner or acquire that company. Corporate venturing can have an external focus, for example, investing in strategically related technology start-ups. Mining companies have been sourcing and investing in start-ups as part of their strategy. Corporate venturing has tremendous potential to accelerate the development of digital transformation in the African mining sector. It does, however, come with a series of challenges like navigating.

01

A challenging entrepreneurial landscape

02

Intellectual property constraints

03

Limited venture capital funds

04

Lack of suitable entrepreneurial skills

Corporate venturing offers a flexible opportunity of advancing digital transformation within the mining sector.

01
Challenging entrepreneurial environment

Globally, entrepreneurs face obstacles in the journey of achieving success in the business world. These obstacles are exacerbated in the African context, as entrepreneurs face barriers in accessing finance, lack of support for innovation, poor infrastructure, and sourcing skilled labour.

02
Intellectual Property constraints

Innovative start-ups face another challenge with South Africa's regulations of intellectual property rights. Commercial exploitation of intellectual property derived from publicly funded research comes with stringent conditions. Support from public institutions, like universities for example, is crucial and the funding into R&D provided to these institutions can act as a catalyst in the innovation process. However, the contrasts of use of publicly funded innovations presents commercialisation challenges for entrepreneurs.

03
Limited Venture Capital Funds

Venture Capital and investment experts at the African Venture Capital Association's conference expressed how South Africa should, ideally, triple the number of venture capital funds operating in the country. As of 2021, Two hundred and two (202) venture capital funds were operating in South Africa across different sectors. Entrepreneurs seeking capital injections for their businesses usually struggle to access capital, especially at the early stages of the business.

04
Lack of suitable Entrepreneurial Skills

South Africa's business landscape requires an advanced skill set from entrepreneurs to overcome challenges and succeed. Opportunities to gather such skills are not easily accessible. In addition to obtaining all suitable skills needed as an entrepreneur, finding skilled labour is often a difficult task.

Case Study: Sibanye-Stillwater iXS initiative

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Sibanye-Stillwater launched its iXS (Innovate, Accelerate and Scale) initiative in partnership with Savant Capital in September 2021. It is an investment programme that develops innovators and entrepreneurs and supports the emerging South African start-up community.

The initiative has three primary objectives:

•   Develop expertise to solve mining related issues through novel entrepreneurial and innovative solutions.
•   Fund the development and adoption of technology from prototype, through proof concept, to commercial readiness.
•   Develop businesses within South Africa's mining value chain such that they achieve commercial viability and global application.

According to Sibanye-Stillwater the company was looking for a meaningful way to participate commercially with start-ups and scale organisations. This initiative could essentially provide Sibanye-Stillwater with another avenue to test new digital technologies in a responsible manner. A challenge that Sibanye-Stillwater faced was that in some cases the technology they interacted with was great, but the commercial aspect underpinning the technology was not appropriate and consequently some businesses had continuity issues.

Case Study: Implats and AP Ventures

Implats is an investor and advisory board member in AP Ventures. AP Ventures manages venture capital funds that invest in the technologies which seek to address today's most pressing global challenges. The AP Ventures portfolio is focused on hydrogen and its role in decarbonising energy. The portfolio aims to deploy capital to invest in technologies with the potential to unlock the hydrogen value chain, enabling the swift transition to sustainable energy. In addition, AP Ventures invests in technologies that use - enable the use of - platinum group metals (PGMs), which have a wide variety of potential applications in producing, storing, releasing, measuring and using hydrogen. Given Southern Africa's dominance in the global mined supply of PGMs, the development of the global hydrogen economy is a key force shaping the future demand outlook and the long-term outlook for the domestic PGM mining industry. AP Venture's operating model also creates the opportunity for co-investment in portfolio companies and enables enhanced South African exposure to technology development, deployment, future manufacturing and sales - and hence the progression of broader industrial development. Implats benefits from the unique ecosystem created by the AP Ventures model through collaboration across the base of key domestic and international co-investors. Finally, Implats believes its investment in AP Ventures creates unique exposure to potential technological solutions to its own decarbonisation goals, across its energy and transport requirements and for its mining and processing value chain.

Case Study: Vale Ventures

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The trend of mining companies branching into the venture capital space is not limited to South Africa, the Brazilian mining company Vale announced in June of 2022 that it is launching a corporate venture capital unit to support start-ups offering disrupting innovations in the mining sector. The business has earmarked $100m for companies engaged in sustainable mining initiatives. The unit is expected to offer initial funding in early-stage investments in start-ups in exchange for minority stakes of 3% to 5% in those companies.

Open innovation in the African mining sector

Open innovation has emerged recently as an innovation model. It encourages companies to use existing external knowledge rather than reinventing the wheel. In this model, it is considered positive to establish links with other companies, universities, technology centres, and other knowledge sources. The ideas are better connected to the market and meet real customer needs, moreover, the developed solutions bring about better technological knowledge. Mining companies that have embraced open innovation could potentially benefit through enhanced agility, reduction In costs and access to a diverse talent pool.

01
Enhanced Agility

Small start-ups often come up with innovations that can disrupt entire industries. One of the reasons behind this is that small start-ups learn how to innovate out of necessity. Innovative start-ups are often more agile and are free to experiment, test and validate innovations without suffering immense reputational damage.

02
Reduction in Costs

According to Exxaro the biggest benefit to open innovation is cost. Leveraging a large and broad ecosystem and partnering with people who have already developed solutions to challenges that Exxaro experiences is a valuable proposition. Another benefit of open innovation is that Exxaro can use a technology or innovation that has already been tried and tested in the market by someone else.

03
Access to diverse talent pool

Sibanye-Stillwater states that another benefit of open innovation is diversity of thought. Open innovation allows companies to partner with talent from different disciplines and harness value from having a second perspective on a challenge. Another benefit of leveraging open innovation is how rapidly people can experiment outside Sibanye-Stillwater's environment. It is harder to do that internally as Sibanye-Stillwater has a specific value chain which is extensive but somewhat limited.

Scaling Innovation and Building an Innovation Mindset

01

Scaling Innovation and building an Innovation Mindset

The process of translating an idea into an innovative product or service is typically riddled with difficulty, taking that innovative product or service, and scaling it to meet the needs of a larger market often comes with more complexity. In order for us to understand what it means to scale an innovation we need to look at the lifecycle of an innovation. Every innovation starts from a rough idea or concept. The idea would then need to be validated and analysed to ensure that it makes sense, and from there it may be necessary to build a product or a service that meets a real need in the market. When there exists an innovation, the next step is then to scale the innovation.

Once an innovation exists, all the pieces to create value may well be in place but the next step would then be to unlock the value for the vast majority of the available market.
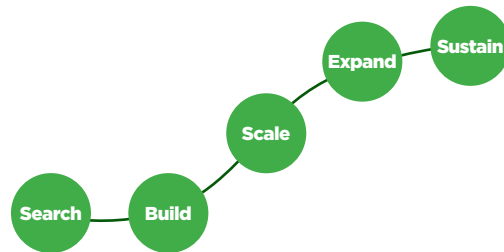**This process can be categorised in the following steps:**

Figure : Process steps to scale innovations

Out of these steps, the scale step is generally the most complex and it's also where most of the value creation and impact comes from. Traditionally, scaling innovation is seen as a matter of advancing the adoption of innovation.

Implats stated that for an organisation to invest capital in scaling an innovation there ought to be a satisfactory level of certainty on the maturity of the innovation. It is difficult for organisations to invest in technologies that have a Technology Readiness Level* that is less than nine.

*Technology Readiness Level (TRL) is a system used to determine the maturity of a technology, it is based on a scale that ranges from 1-9, with 9 being the most mature technology.

Building an Innovation Mindset

The process of scaling an innovation involves implementing a suitable change management strategy to ease the adoption of an innovation within an organisation.

According to Exxaro in order to do this, all the various stakeholders that are responsible for bringing in digital solutions, whether it be an engineer or someone in Human Resources, have to be in a position to understand why they need to change a process or technology. Additionally, they need to understand what the impact will be and then they need to be in a position to shape the change. They need to have a clear vision of the outcome of implementing the solution that is being brought into the organisation. Another crucial aspect is that stakeholders need to understand that they would be collaborating on the change. They need to be aware that they cannot implement change management on their own.

Exxaro stated that it is important to have leaders in the organisation that drive change management. One cannot implement change management on their own and it becomes important to help people understand that they are all agents of change management. Stakeholders that are going to be implementing solutions and be impacted by those solutions need to understand change management and be in a position to effect change management.

These sentiments were echoed by SASOL, they outlined how building an innovation mindset in an organisation cannot be the sole responsibility of one department within that organisation. The whole organisation should take it upon themselves to embrace innovation.

Case Study:Anglo Platinum Digital Skills

As part of their efforts to scale and facilitate the adoption of digital technologies and skills, Anglo American rolled out a comprehensive information and communication technology (ICT) programme in 109 schools around its mining operations. The rollout costed an estimated R70 million and included installing technology infrastructure and devices in all schools as well as providing ICT courses and training to improve digital literacy and skills

Conclusion

Emerging technologies have an incredible potential to assist mining companies to stay competitive and profitable in the face of volatile commodity prices and increasing ESG regulations. Artificial intelligence, machine learning, digital twin, internet of things and the metaverse are finding application in the African mining sector.

Innovation and digital managers face unique challenges and coordination, collaboration and increased synergy, firstly within their business and then with external bodies; governments, academia and business is crucial to advancing digital transformation.

Contributors

Alex Fenn
Senior Manager, Technology and Innovation at Sibanye-Stillwater

Alex Fenn is the Head of Innovation at Sibanye-Stillwater. A South African native, his mission is to make a difference and add significant value to the broader metals industry through innovative solutions to significant global challenges developed at Sibanye-Stillwater. As Head of Innovation, he coordinates the Group's research and development, and innovation initiatives, identifying opportunities for shared value creation through means, mechanisms and technologies. Prior to his current role, Alex served in numerous roles associated with Engineering and Improvement.

Mzwandile Buthelezi
Group Head, Innovation and Technology at Implats

Mzwandile Buthelezi [Pr Eng] is the Group Head of Innovation and New Technology at Implats. He is an electrical & electronics engineer with more than 16 years' experience mainly in the mining sector and power utility industry. He is passionate about inspiring people to adopt an innovative mindset enabling them to embrace the everchanging world. He believes that the mining sector is poised to endorse advancement in technology. He specialises in innovation strategies including identification and deploying appropriate technologies that support mining operations across the value chain. He was instrumental in the development of the first in the world collision avoidance technology for oper-cast operations together with OEMs (Original Equipment Manufacturers)

Contributors *(continued)*

Bramley Maetsa
Head of delivery enablement at SASOL

Sasol is a global chemicals and energy company, operating in over 22 countries. Bramley Maetsa is a senior manager of Digital Innovation Enablement at Sasol. Bramley has 17 years of experience working in IT, ranging from consulting, product development and service management in different geographies. He was part of the digital transformation programme and successfully implemented Citizen Development and DevOps to enable fusion teams to build digital products at customer speed. He is currently working on maturing adoption of AI in IT operations (AIOps), implementing Employee Digital Experience concept and investigating IT technology future trends.

Elaine Hattingh
Manager: Innovation, Planning and Execution at Exxaro

As Manager Innovation at Exxaro Resources, Elaine Hattingh enables and supports the sourcing and deployment of disruptive innovations with the aim of solving business challenges and supporting innovation to maximize value for all stakeholders.

She has a B.Sc Hons in Geology and M.Sc Eng in Mining Engineering. She has deep rooted experience within the geomodelling space and spent time within multiple mining operations in her career. In addition to her mining related experience, she has experience in the corporate venturing space where she evaluated businesses' performance to establish viability leading to potential investments within the agricultural, energy and water sectors."

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About COOi Studios

COOi Studios is an innovation accelerator partner to corporates, start-ups and government organisations. We help enterprises accelerate innovation to deliver exponential growth using our highly-tuned innovation methodologies. We work with business leaders to drive innovation culture and rapidly deliver emerging technology innovations (AI, VR, AR, IoT, Robotics and 3D printing).

We look forward to hearing from you and partnering with you in an exciting, innovative journey.

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