

# Innovate:

Issue 16 2021

## A REIMAGINED FUTURE

Hydropower for rural communities

Digital neural networks for rail safety

The Hatfield Digital Twin City

Humanising technology

Relieving digital fatigue

XR Technology



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA

Faculty of Engineering,  
Built Environment and  
Information Technology

Fakulteit Ingenieurswese, Bou-omgewing en  
Inligtingtegnologie / Lefapha la Boetsenere,  
Tikologo ya Kago le Theknolotši ya Tshedimošo

# Innovate:

Issue 16 2021

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## ON THE COVER

### A REIMAGINED FUTURE

*The Faculty of Engineering, Built Environment and Information Technology at the University of Pretoria is bracing itself for a dynamic digital future. Through its thought leadership, the Faculty is preparing to tackle the challenges of the future with a generation of problem-solvers and innovators who are ready to change the world.*

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# Department of Mining Engineering celebrates its diamond jubilee

60 YEARS  
OF MINING  
ENGINEERING



The Department of Mining Engineering is proud to celebrate its diamond anniversary in 2021. With its history of 60 years of excellence in mining engineering education, the Department plays a significant role in mining teaching, learning and research at the University of Pretoria (UP), and contributes new ways of innovating for the future.



*Excellence in Mining  
Engineering Education*  
1961 - 2021 A Diamond Celebration

Established in 1961 following the successful institution of the Faculty of Engineering at UP in 1956, the Mining Engineering programme had been hosted in the erstwhile Faculty of Mathematics and Natural Science since 1956.

The institution of an independent department 60 years ago was necessitated by the recognition of mining engineering as an important discipline in South Africa.

The Department's first intake comprised five students who had come from other departments. Its first students to enrol for the degree in Mining Engineering graduated in 1968. By that time, 25 students had graduated from the Department. It has since contributed greatly to the mining industry by providing world-class mining engineering leaders, with many alumni serving the mining industry with distinction.

Over the years, the Department has faced many challenges, with its strategic intent following the ebb and flow of the fortunes of the industry. However, it has proved to be resilient and ready to turn challenges into opportunities.

This was demonstrated most recently in 2020 when the challenges posed by the COVID-19 pandemic caused it to embrace disruptive approaches to teaching and learning, and to emerge more agile and flexible than ever before.

The change of its language of tuition to English in the late 1990s to facilitate access, the present strong emphasis on leadership skills grounded in sound technical skills, and contributions to inculcating a safety culture in mining operations serve as further examples through which it ensures the delivery of work-ready graduates.

Through its Mining Resilience Research Centre (MRRC), the Department strives to enable the mining industry to transition from being reactive and compliant to becoming resilient in issues related to safety, health, environmental sustainability, social responsibility and community management through well-structured and committed undergraduate and postgraduate education and research. It is therefore dedicated to visibly aligning its educational and research objectives with industry needs.



**EDUCATING AND LEADING MINING ENGINEERS TO BECOME IMAGINEERS BY EMPOWERING THEM WITH TECHNICAL AND NON-TECHNICAL SKILLS THROUGH THE USE OF WORLD-CLASS EDUCATION, RESEARCH, LEADERSHIP AND RELATED TECHNOLOGY INTERVENTIONS.**



## INDUSTRY FOOTPRINT

As an important role-player in the South African economy, the country's mining industry is optimally positioned to embrace the disruptive technologies that characterise the Fourth Industrial Revolution (4IR). In this regard, the Department partners with industry by supplying it with between 15 and 20% of its mining engineering graduates. The Department's innovative teaching practices and relevant research are highly regarded by industry.

The Department collaborates with various stakeholders, such as the Minerals Council South Africa (MCSA), the Mandela Mining Precinct (MMP) as part of the South African Mining Extraction Research Development and Innovation (SAMERDI) strategy and the Mine Health and Safety Council (MHSC), which makes it a key participant in future innovations in the mining industry.

Through the generous financial support of its industry partners, the Department has been able to develop world-class teaching and research facilities, such as the Kumba Virtual Reality Centre for Mine Design, the infrastructure development that included new offices for the Department on the fifth floor of the Mineral Sciences Building and a new mining exhibition centre, as well as industry-supported research chairs.

It is able to support students financially through the provision of industry-sponsored bursaries, which have also been rolled over to full-time postgraduate students in the Department over the last 10 years to build capacity and capability in terms of future researchers and potential academic lecturers.

Industry support has contributed to the development of a robust continuing education programme. The presentation of short courses in conjunction with Enterprises

University of Pretoria (Enterprises UP) forms an important part of the Department's third-stream funding strategy. The Department furthermore benefits from the expertise of leaders from industry and academia, who serve on the Mining Engineering Advisory Board.

## ALUMNI FOOTPRINT

The Department's alumni are among the country's leaders in mining and other industries, such as oil and gas, as well as water purification, locally and abroad, and include a significant number of individuals who serve in the leadership ranks of prominent organisations and on their boards of directors, and are recognised for the role they play in the development of the country's economy.

The Department's many alumni who are employed at senior executive level in the mining industry are a true testament to the quality of graduates that the Department has produced over the last 60 years, and will continue to produce. These individuals are champions for the University of Pretoria, and enhance its image through their exceptional achievements as the chief executive officers, chief operating officers, managing directors and executive heads of various mining companies.

The Department also enjoys the active support of its alumni through the Mining Alumni Society of the University of Pretoria (MASUP), the University's largest alumni society. Through this platform, alumni support the Department by raising sponsorships, and ensuring that a high level of skills and educational standards are maintained. This society also serves as a social network for mining engineers in industry.

## INTERNATIONAL FOOTPRINT

The University of Pretoria is recognised as one of the top 50

universities in the world in minerals and mining engineering according to the QS World University Subject Rankings of 2021. It is one of only two departments in South Africa to educate professional graduate mining engineers. Its graduates are well accepted in the market, and its racial and gender profiles are fully representative of the South African landscape.

The Department's prime resource is its teaching staff, which has about 150 years of combined industry experience. The active participation of industry experts as part-time lecturers forms an important part of its teaching strategy. The financial contribution of the Minerals Education Trust Fund (METF), in the form of a staff salary subvention, has enabled the Department to attract high-quality lecturers from industry. The additional involvement of guest lecturers keeps its staff and students up to date with the latest industry trends. Its postgraduate research programme has benefitted from the involvement of Prof Con Fauconnier as honorary professor and Prof Bharath Belle, Prof Jan du Plessis, Prof John Napier and Prof William Spiteri as extraordinary professors.

One of the Department's key strategic initiatives is to ensure that its research is recognised internationally for its high standards. The intention is to increase the collaboration potential among international researchers with similar technical subject knowledge and skills, and to foster international co-publication.

The Department is also a member of the global academic community through its representation of the University of Pretoria on the International Society of Mining Professors (SOMP). This body represents mining academics all over the world, and is committed to making a significant contribution to the future of the minerals discipline internationally. All the Department's lecturers are members of this organisation.



**AS AN IMPORTANT  
ROLE-PLAYER  
IN THE SOUTH  
AFRICAN ECONOMY,  
THE COUNTRY'S  
MINING INDUSTRY  
IS OPTIMALLY  
POSITIONED  
TO EMBRACE  
THE DISRUPTIVE  
TECHNOLOGIES THAT  
CHARACTERISE THE  
FOURTH INDUSTRIAL  
REVOLUTION.**



## FACILITIES

The Department's excellent relationships with its industry partners led to the establishment of the Kumba Virtual Reality Centre for Mine Design (VR Centre), which was made possible through an R18.8 million investment over three years by Kumba Iron Ore in 2013. This was the first centre of its kind in Africa to be housed at a university, and enables the Department to realistically simulate a range of mining functions in a low-risk, high-impact learning environment.

The facilities comprise a wall-to-wall 3D theatre, as well as an immersive mine simulation theatre, which casts 360° images against dark surrounding panels with cinematic clarity and highly realistic sound effects. The infrastructure development, which was completed in 2015, included new offices for the Department on the fifth floor of the Mineral Sciences Building, while African Rainbow Minerals provided funding for

a new mining laboratory and exhibition centre.

In 2019, the METF made a substantial sum available to the Department to acquire new laboratory equipment for mining modules. This new equipment has added to the Department's virtual reality theatre and 360° cylinder, and will ensure that it can cater for new needs in terms of technology transfer to enhance students' learning experience and understanding. The support of the METF is graciously acknowledged and appreciated.

## RESEARCH EXCELLENCE

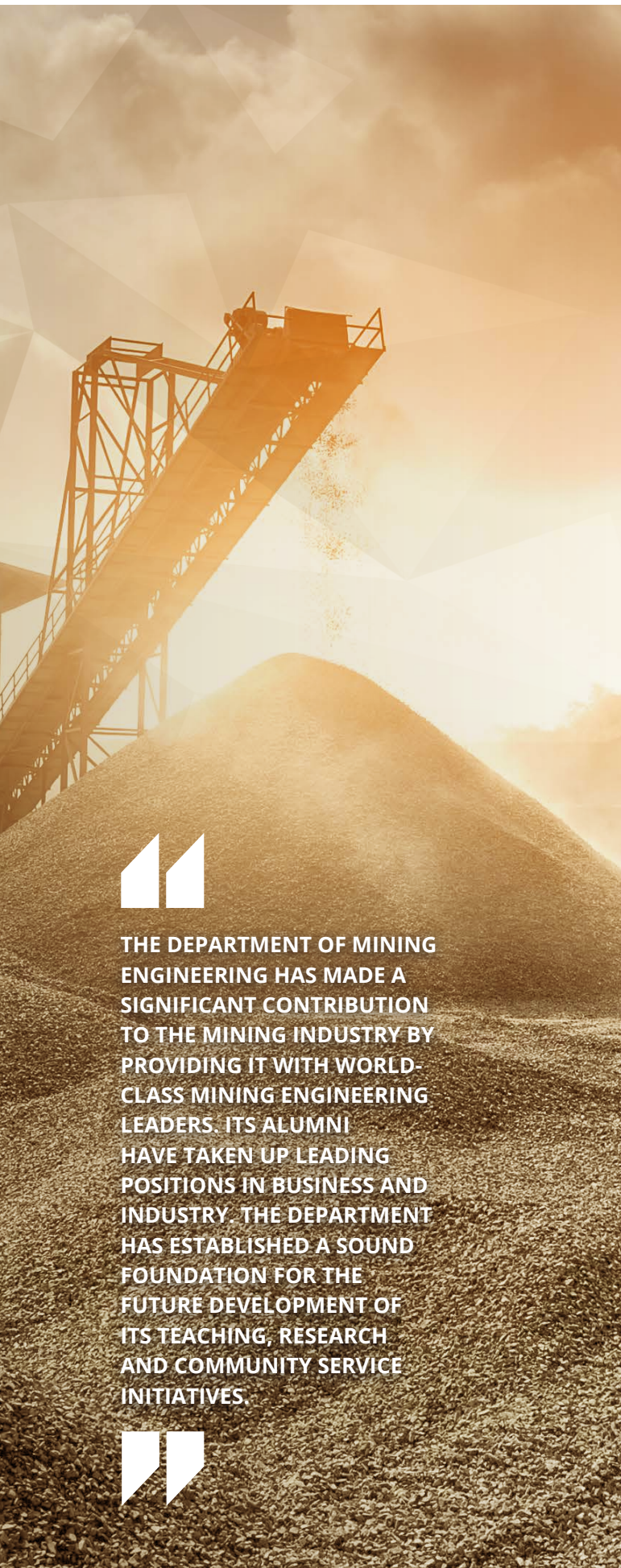
The Department is concentrating its efforts on growing research capacity in five key research areas, which will have an impact on the future of mining and the sustainability of the industry: mechanisation and automation, rock-breaking and explosives engineering, management and

leadership, rock engineering and extended reality (XR) technology.

The strategic intent of the Department to increase its postgraduate student numbers has a direct impact on its research output. It is increasing its publications in national peer-reviewed journals and at conferences, and has a healthy research pipeline. The challenge that it is embracing is to increase publications in accredited international journals and cement its relationships with international mining schools. The appointment of extraordinary lecturers with PhDs in future to fill the gap in research areas that the Department wants to explore will become more important and, in this way, increase its research capacity and capabilities.

Prof Francois Malan, the Department's Research Function Head, has a B2 rating as a researcher from the National Research Foundation (NRF), which signifies an internationally acclaimed researcher.





**THE DEPARTMENT OF MINING ENGINEERING HAS MADE A SIGNIFICANT CONTRIBUTION TO THE MINING INDUSTRY BY PROVIDING IT WITH WORLD-CLASS MINING ENGINEERING LEADERS. ITS ALUMNI HAVE TAKEN UP LEADING POSITIONS IN BUSINESS AND INDUSTRY. THE DEPARTMENT HAS ESTABLISHED A SOUND FOUNDATION FOR THE FUTURE DEVELOPMENT OF ITS TEACHING, RESEARCH AND COMMUNITY SERVICE INITIATIVES.**



The Department's postgraduate teaching and research is supported by its industry chairs, as well as the Mining Resilience Research Centre. These are the AEL Intelligent Blasting Chair for Innovative Rock-breaking Technology, the Harmony Gold Chair in Rock Engineering and Numerical Modelling, and the Murray & Roberts Chair in Industry Leadership 4.0. It also collaborates with the Department of Information Science on the Exxaro Chair in XR Technology. In addition, the Mandela Mining Precinct, an initiative of the Department of Science and Innovation, approved the establishment of the SAMERDI Research Centre for Mechanised Mining Systems (MMS) at the University of Pretoria, to be officially launched in November 2021. This centre is a joint initiative with the Department of Mechanical and Aeronautical Engineering. Its research activities relate to continuous rock drill condition assessment; an estimation of rock strength properties using selected mechanical parameters obtained during drilling; and the predictive maintenance management of mechanised mining equipment.

In recognition of the fact that a resilient mining industry is of particular relevance to Africa, the Department launched the Mining Resilience Research Centre in 2017. This multidisciplinary research centre draws on

the resources within the University's nine faculties, matching the right skills sets to any mining problem. It contributes to finding practical solutions to complex mining problems related to productivity, safety, health, environment, social responsibility and community management challenges. It does this through well-structured and committed postgraduate education and rigorous, integrated, scientific research initiatives. It pursues practically implementable solutions, educates graduates who are equipped with relevant skills and conducts collaborative contract research for industry. In the process, it contributes to strengthening the University's mining footprint, as well as its national and international minerals research profile.

This forms part of the Department's long-term strategy to become a world leader in mining research for practical implementation, and is well supported by Enterprises UP with regard to the contractual and administrative arrangements associated with applied research in particular.

The activities of the MRRC have enhanced the Department's capabilities by utilising research capacity from other departments in various faculties at the University to actively participate in mining research. It also supports the MHSC with research projects.

## TEACHING AND LEARNING

The Department has developed innovative teaching and learning initiatives. These are aimed at supporting undergraduate students and enhancing the Department's throughput and success rates, while ensuring that it delivers well-rounded mining engineers to the workforce.

### Leadership development

The development of its students as future managers and technical specialists remains a priority and the development of life skills and responsible leadership through participation in student activities is continuously encouraged. As a result, graduates from the Department are employed in a wide range of companies both locally and internationally. According to the latest available statistics, approximately 95% of the Department's graduates from 2018 and 2019 are employed in various fields in the minerals sector, as well as in consultancies and financial institutions.

Prospective mining engineers need to be able to deal with up to five different generations of workers in the workforce, and this requires special skills. To address this challenge, the Department is grooming its students for the modern workplace by equipping them with various non-technical skills that promote creative and innovative thinking to enable them to deal with the complexities of the mining industry.

This initiative, known as the Murray & Roberts Mining Engineering Leadership Academy (M&R MELA), forms part of the Murray & Roberts Chair in Industry Leadership 4.0. It focuses on the development of leadership and communication skills, as well as conflict resolution, problem-solving and stress management skills.

It also plays an important role in addressing the challenges pertaining to the next generation of mining. These need to be dealt with much differently than in the past.

### English literacy support drive

Another initiative to support students to succeed academically is the English literacy training drive, which was launched in the Department in 2014. This was developed following the identification of students' mastery of the English language as one of the challenges that affects their academic performance, since only 7% of the Department's students have English as their first language. The fact that English is the language in which they have to study can become a hurdle to adequately understand and communicate their understanding of complex concepts. The Department's dedicated English support staff give presentations, conduct testing, present writing workshops and offer private consultations that are aimed at providing students with individualised solutions for their language skills improvement.

### Industry visits

Industry visits form part of the Department's curricula. Each year, the Department's third-year class visits mining operations in industry. During these visits, students are exposed to real-life mining activities before completing their studies.

### Industry capacity-building

The Department presents in-house leadership development short courses to the staff of leading mining companies on their own premises.

## STUDENT WELLBEING

An important focus of the Department is the wellbeing of its students. Its interaction with its students takes place according to a value-driven framework, in which the principle of heartfelt leadership features prominently.

The values it entrenches in its students are those of respect, care, honesty, integrity and trust. In accordance with these values, it has established a Student Wellbeing Committee, which offers emotional and other support to students. Where possible, the Department also lends support to avert any anxiety students may experience during their studies, especially students who are in need. Confidentiality is guaranteed and all cases are handled on merit.

In the extraordinary circumstances brought about by the nationwide lockdown and related COVID-19 regulations in 2020, several challenges had to be overcome. These included the availability of data for students, access to laptops and the narrated recording of lectures. In addition, it was found that a real level of uncertainty and anxiety was prevalent among students regarding the resources available to support their online needs.

In this regard, both the Faculty and the University as a whole were instrumental in their efforts to make free data available, supply laptops to students on a loan basis, accommodate students in the University's residences and issue travel permits. Without these support initiatives, an effective roll-out of the online approach to teaching, learning and assessment would not have been possible.

Under normal circumstances, students are assisted in other ways as well, including the provision of prescription glasses, daily meals, accommodation and registration fees. The Department also receives financial assistance from industry for student support, including annual donations from MASUP and other industry partners. The Southern African Institute of Mining and Metallurgy also supports students in their early years of tertiary education on a year-by-year basis through its Scholarship Trust Fund.



## NETWORKING AND MENTORSHIP

Mining engineering students are given the opportunity to network and socialise with other students and staff of the Department outside lecture halls through the Tuks Mining Society, a student organisation that supports the Department's students on a holistic level. A mentorship programme is in place where junior students are assigned senior students to assist them with academic issues and provide guidance based on personal experience.

## THE WAY FORWARD

With commodity prices picking up, and the fact that nothing that is happening in the 4IR would be possible without mining, it is clear that mining will remain a major contributor to the country's GDP for many years to come. The many challenges associated with Mining 4.0 (next-generation mining) form an integral part of the Department's teaching, learning and research activities.

Although not many new mines are being opened in South Africa, it is becoming increasingly important to enhance the productivity of the country's existing mines. By adopting new technology interventions and mining methods, as well as focusing on the health and safety of our workforce, mine management is realising that it is no longer a question of whether one should embrace technology, but when one should do so. An essential element in our quest for increased productivity is mine management's awareness of its social responsibility.

According to Dr Gordon Smith, a member of the Department's

Advisory Board, "mining engineers who are strongly grounded in Industry 4.0-enabling technologies and systems engineering, as well as in change management and innovation, will be integral to the success of mining operations in the future".

In a recent report by Swan Global Investments on addressing the mining skills gap, the authors mention that, for the next 25 years, there will be a high demand for metals in the world to meet the requirements pertaining to the 4IR. The report amplifies the pressing skills shortage that needs to be addressed as students' interest in mining declines, and the industry becomes increasingly characterised by an ageing workforce that needs to be replenished. It furthermore highlights five key areas for the lack of interest in mining: a lack of information pertaining to mining, climate change, resistance to coal-fired power stations, which are detrimental to a healthy lifestyle, uncertainty in job opportunities due to the cyclical nature of mining, and politics.

From this, it is evident that mining schools across the world are looking at different ways of attracting students. What the mining engineer of the future should look like is a very important topic that is being debated worldwide. Different ways can be explored to increase the attractiveness of mining as a career option, including collaboration with other engineering disciplines. In this way, mining engineers can be equipped with new skills that are not only appropriate for the present, but also for the future beyond the 4IR.

We are standing on the threshold of the Fifth Industrial Revolution. This new era is set to highlight the significance of humanity in the workplace. This future era will build on the 4IR and it is foreseen that it will be an artificial intelligence (AI)

revolution, with the potential of quantum computing, which will draw humans and machines together in the workplace.

It will be about harnessing the unique attributes of AI by recruiters and employers who, in effect, will be more equipped to make even better and more informed decisions. The importance placed on human intelligence will be greater than ever before.

The Department of Mining Engineering is already starting to think beyond the 4IR, and to prepare its students for the Fifth Industrial Revolution. This future era may need an entirely new set of skills to cope, but in many ways, should complement the skills identified to thrive in the 4IR.

It is clear that industries and related work have changed forever, and the mining industry is no exception. This further amplifies the need for a specific leadership approach that can accommodate the various complexities and deal with them accordingly. 🌱



**OVER THE YEARS, THE DEPARTMENT HAS FACED MANY CHALLENGES, WITH ITS STRATEGIC INTENT FOLLOWING THE EBB AND FLOW OF THE FORTUNES OF THE INDUSTRY. HOWEVER, IT HAS PROVED TO BE RESILIENT AND READY TO TURN CHALLENGES INTO OPPORTUNITIES.**







Prof John Napier

## Sir John Napier:

A distinguished extraordinary professor in the Department of Mining Engineering

FACULTY  
NEWS



The Department of Mining Engineering's postgraduate research programme has benefitted from the expertise of several experienced and highly qualified academics as extraordinary professors. One of these is Prof John Napier – or Sir Napier if one were to use his hereditary title!

Although South African by birth, Prof Napier's English ancestry goes back centuries, and he has many illustrious forebears, the most notable of which is John Napier (1550–1617), a Scottish mathematician and philosopher who invented logarithms. Prof Napier holds the title of 14th Baronet of Merchiston (also known as Sir Napier). The baronetcy is a hereditary title passed to the eldest son. The Napiers' ancestral home was Merchiston Castle in Edinburgh, which today forms part of Napier University.

Prof Napier originally trained as a chemical engineer at the University of the Witwatersrand (Wits), graduating with a BSc degree in 1967. After working in the oil refinery industry for two years, he completed an MSc in Chemical Engineering at Wits. He then joined the Chamber of Mines Research Organisation (COMRO) and worked extensively on problems of operations research relating to coal mine production planning and gold mine planning.

He completed his PhD at Wits in 1980 with research focused on the development of an econometric model of gold mine capital expenditure and the analysis of optimal cut-off grade selection policies. While at COMRO (and later the CSIR Division of Mining Technology), he developed a computer code for the analysis

of large-scale tabular mining excavations (MINSIM-D) that has been used extensively in the South African gold mining industry.

He is internationally renowned for his special expertise in rock engineering and numerical modelling. His recent research activity has concentrated on the development of a computer program to analyse tabular mines for countless layout designs. This program has been used extensively in South African gold and platinum mines.

Prof Napier is world-renowned for the development of a displacement discontinuity computational method to simulate three-dimensional fracture growth with application to hydraulic fracturing, mixed mode fracture propagation and dynamic rock fracture processes near mine excavations. His research interests have furthermore included the econometric modelling of deep mine capital expenditure and the application of optimal control methods for the selection of cut-off grade levels in tabular gold mining.

He supervised or co-supervised six PhD students in work related to rock mass behaviour research at the CSIR between 1990 and 2004; three of whom (including Prof Francois Malan, the Department's Research Function Head) received the

prestigious Rocha medal of the International Society of Rock Mechanics for the best PhD thesis in rock mechanics in the world. This record is unmatched in any country. To add to this achievement, his legacy of expertise at the University of Pretoria led to a student supervised by Prof Malan, in turn, also receiving this prestigious award. Dr Michael du Plessis is currently employed as a Mining Engineering Manager at Gold Fields.

Prof Napier is a member of the American National Academy of Engineering. This is one of the highest professional distinctions that can be accorded an engineer. It is awarded to those who have made outstanding contributions to engineering research, practice or education, including significant contributions to engineering literature, pioneering new fields of technology, advancements in engineering practice and innovative approaches to engineering education.

He was elected as an international member of the American National Academy of Engineering (NAE) in 2018 and is a Fellow of the Southern African Institute of Mining and Metallurgy (SAIMM). He has authored and co-authored 43 papers in peer-reviewed journals and approximately 47 national and international conference papers. ➔

# Interdisciplinary research in XR technology explores mining-related challenges

The University of Pretoria supports research to challenge the obstacles associated with the Fourth Industrial Revolution (4IR). With the support of Exxaro, one of the country's top five coal producers, a strategic intervention has been launched to deal with challenges related to mining by utilising extended reality (XR) technology.



**XR TECHNOLOGY REFERS TO ALL REAL AND VIRTUALLY COMBINED ENVIRONMENTS, AS WELL AS HUMAN-MACHINE INTERACTIONS GENERATED BY COMPUTER TECHNOLOGY, INCLUDING AUGMENTED REALITY, MIXED REALITY AND VIRTUAL REALITY.**



The establishment of the Exxaro Chair in XR Technology in the Department of Information Science is another milestone for the Faculty of Engineering, Built Environment and Information Technology. It recognises research in the field of multimedia, as well as the collaboration between the Faculty's departments of Information Science and Mining Engineering. University Vice-Chancellor and Principal, Prof Tawana Kupe, believes that this Chair will be a game-changer for training in mining operations, particularly mine safety.

This Chair is the outcome of negotiations originating in the Department of Mining Engineering, as well as the vision and initiative of Head of Department, Prof Ronny Webber-Youngman, together with Koos de Beer from the Department of Information Science and Jannie Maritz from the Department of Mining Engineering. While the all-pervasive nature of XR technology and its applications in many sectors is evident, the resources of a JSE-listed company like Exxaro will enable the University to optimise the relevance of this technology for mining-related challenges.

The generous funding of Exxaro over a three-year period will contribute to making the University a leader in digital transformation on the African continent, and prepare its graduates for the future of work. Among other things, developers will be appointed to work on applications in virtual reality (VR) and augmented reality (AR) in Exxaro's training facilities, and to improve production and technology selection. It will also build capacity and expertise among developers, and create opportunities for students in Multimedia and Mining Engineering to work on industry-related projects. This investment in technological advancement will furthermore allow ongoing research to be undertaken to establish a safer, more economic and more environmentally sensitive form of mining.

Exxaro's decision to invest in this technology was motivated by several factors within the context of digital transformation. The future needs innovative technology to cope with the challenges of the 4IR, and XR technology offers a strategic intervention to deal with these mining-related challenges.





From left: Prof Ina Fourie (Head of Department: Information Science), Prof Sunil Maharaj (Dean: Faculty of Engineering, Built Environment and Information Technology), Mxolisi Mgojo (CEO: Exxaro), Prof Tawana Kupe (Vice-Chancellor and Principal: University of Pretoria), and Prof Ronny Webber-Youngman (Head of Department: Mining Engineering) at the launch of the Exxaro Chair in XR Technology.

As mining and other industries are investing in XR technology solutions to optimise their resources, the ubiquitous nature of this technology and its applications need to be explored in terms of their relevance to the mining industry. Based on the fact that many companies lack the know-how to successfully implement XR technology, this investment will make Exxaro a leader in this field.

The Virtual Reality and Interaction (VRI) Laboratory in the Department of Information Science, in which the Chair will be located, is already actively involved in research and development, as well as the education of future developers, designers and researchers related to XR technology across a wide spectrum of contexts. With the support of the Department of Mining Engineering, it can thus extend its scope to working with mining applications as well.

The Exxaro Chair in XR Technology will offer a framework of how XR technology can be used to address challenges in the mining industry and identify which of the available technologies will provide the best solutions. Through its XR technology

programme, the two collaborating departments will therefore be able to do the following:

- Select the most effective XR technology for specific applications, and design interactions that enable intuitive interaction with virtual environments.
- Perform extensive user testing of proposed solutions to ensure that the selected solutions best address the identified challenges.
- Expose users to XR technology through creative and interactive paradigms and experiences, making the application of XR technology as accessible as possible.
- Educate and train the next generation of developers and researchers with real-world projects unique to XR technology and immersive learning.

Speaking at the official launch of the Exxaro Chair in XR Technology on 1 September 2021, Prof Ina Fourie, Chairholder and Head of the Department of Information Science, expressed her enthusiasm at the support of the mining company in this initiative.

***“Exxaro is opening new opportunities for us to excel in industry-related XR research. It is offering us an opportunity to become international leaders in the use of XR technology in the mining industry and mining safety. Many other applications and opportunities can follow.”***

The Chair will likewise give Exxaro access to the XR intervention expertise and facilities in the two collaborating departments. It will also provide a channel to contribute towards the social development of the people of South Africa by identifying suitable postgraduate students and providing them with financial support through bursaries as part of the objective to build XR technology capacity and capability.

Exxaro’s support will furthermore enable UP to educate and train the next generation of developers and researchers with real-world projects unique to XR technology and immersive learning. According to Exxaro CEO, Mxolisi Mgojo, the company is keen to explore the potential benefits of XR technology as a strategic intervention across its operations.

*“Together with the University of Pretoria, we are expanding on the practical capabilities of XR in the South African context, while supporting our need for industry to embrace the opportunities of the 4IR.”*

The XR technology programme will assist in selecting the most effective XR technology for specific applications, and then design interactions that can enable intuitive interaction with the virtual environment. It will also offer extensive user testing of proposed solutions to ensure that the solutions address and solve as many challenges as possible.

*“We are extremely excited about this partnership as part of our drive to support research that overcomes the obstacles associated with the 4IR,” Mgojo said. “We believe that XR technology has immense applications for dealing with mining-related challenges and can optimise the resources of companies like Exxaro.”*

According to Prof Ronny Webber-Youngman, Head of the Department of Mining Engineering, collaboration with the Department of Information Science will contribute to improving the safety, health and productivity of the mining industry, while enhancing sustainability and ensuring responsible mining through the use and implementation of XR technology.

The following research topics in the Department of Mining Engineering have already been identified, which will make use of the expertise of the XR Technology Chair:

- The current state of XR technology in South Africa’s mining industry
- Application areas for XR technology in the South African mining industry
- The use of XR technology on all levels of the mining operation

The collaboration of the Department of Information Science and the Department of Mining Engineering in this initiative further enhances the University’s objective of promoting interdisciplinary research to solve the challenges faced by society. 🌐

**THE EXXARO CHAIR IN XR TECHNOLOGY WILL OFFER A FRAMEWORK OF HOW XR TECHNOLOGY CAN BE USED TO ADDRESS CHALLENGES IN THE MINING INDUSTRY AND IDENTIFY WHICH OF THE AVAILABLE TECHNOLOGIES WILL PROVIDE THE BEST SOLUTIONS. IT WILL ALSO GIVE EXXARO ACCESS TO THE XR INTERVENTION EXPERTISE AND FACILITIES IN THE TWO COLLABORATING DEPARTMENTS. THIS WILL PROVIDE A CHANNEL TO CONTRIBUTE TOWARDS THE SOCIAL DEVELOPMENT OF THE PEOPLE OF SOUTH AFRICA BY IDENTIFYING SUITABLE POSTGRADUATE STUDENTS AND PROVIDING THEM WITH FINANCIAL SUPPORT THROUGH BURSARIES AS PART OF THE OBJECTIVE TO BUILD XR TECHNOLOGY CAPACITY AND CAPABILITY.**





# Gen Z gamers are preparing themselves for a new way of learning and doing

Prof Ronny Webber-Youngman

Youngsters of school-going age who demand more screen time than the average adolescent are already acquiring the skills needed for exposure to new ways of learning and doing. This includes those related to technologies such as virtual reality (VR), augmented reality (AR) and extended reality (XR). These are essential skills when enrolling for university courses in science, technology, engineering and mathematics (STEM). Their predilection for gaming as a preferred way of spending their time therefore has unintended benefits.

Learning techniques such as gamification and gameful design are aligned to the requirements for the training of developers in the Exxaro Chair in XR Technology in the Department of Information Science. This programme not only creates opportunities for students in multimedia, but also in industry-related projects such as those in the mining sector.

Gamification is defined as the use of game design elements in a non-game context, while gameful design has the goal of affording the motivating, enjoyable experiences that are associated with game play in non-gaming contexts.

Interactive immersive technology (IIT) is a methodology used in the Department of Mining Engineering, building on the success of its Kumba Virtual Reality Centre for Mine Design, that presents real-world scenarios for immersive experiences by means of VR. Systems related to IIT in education and training, particularly in mine contexts, have several benefits. Face-to-face education and training are not always possible and take much longer than making use of technology, especially in the case of large groups.

In mines, different literacy levels make the visualisation of certain scenarios an important aspect to further enhance the learning and knowledge application experience. The implementation of IIT is already changing the way we learn and apply knowledge in education and training. It has also been proven to promote knowledge retention and application. Immersive education is furthermore designed to engage trainees, giving them the sense that they are involved on the ground. The mobility of AR that incorporates smart phones provides added value to the accessibility of the technology.

Extended reality takes the innovative technologies that are able to cope with the challenges of the Fourth Industrial Revolution (4IR) a step further by combining different virtual platforms. It can then be utilised in combination, in various practical applications, to cover the continuum that ranges from the real-world environment to the virtual world. In this regard, VR and AR function to merge the real world with the virtual world through interactive technologies that can function across various dimensions.

It is becoming increasingly important for the mining industry to embrace the opportunities posed by the 4IR. It is almost no longer possible for a mine or any other industry to operate without the benefits inherent in AR- and XR-based training, which encompass future-driven visualisation.

The world has entered a visual phase. The concept of gamification among the youth, and even older people, is no longer alien, and has become very advanced in terms of the visual and interactive dimensions in which the action takes place. Within the academic space, and by extension, industry training, game design elements are increasingly used in a non-gaming environment.

In the past, the mining industry mostly responded reactively to mine accidents and aspects related to mine safety and productivity. This was because information regarding such matters was only available after the fact, which meant that a great deal of time passed before problems could be addressed and preventative measures put in place.

In the digital environment in which we currently find ourselves, there is no reason not to be proactive in terms of mine health and safety, as well as productivity, in order to ensure a sustainable industry. The modelling of scenarios in a virtual environment makes this possible.

This reimagined environment provides an ideal setting for tech-savvy youths, and those with an interest in gaming and game design will find themselves priorly skilled. The future generation of students is, without a doubt, favourably inclined towards a more visual way of learning. Their creativity makes an added contribution to the solutions that can be developed through this interactive technology.

Online learning, which has become a characteristic of the way of life during the COVID-19 pandemic, has already illustrated the benefit of an interactive approach to retain learners' attention. XR technology will play an increasingly important role in the future. This will also contribute to the development of new career options that do not even exist in terms of the application of 4IR-related technology – also in the mining industry.

With the application of new skills, such as those provided by XR technology, the mining industry is becoming an attractive career option for the youth – including women – as it opens up the possibility of humanising technology to the benefit of society, the industry and the environment.

This new way of doing things will increase the viability of a career in the mining industry. This benefit will extend beyond the traditional mining careers to enhance operations and opportunities in other industries as well. ➔



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