DEPARTMENT OF MINING ENGINEERING

ANNUAL REVIEW 2018/19

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 Boetšenere, Tikologo ya Kago le Theknolotši ya Tshedimošo

CONTENT

ACRONYMS AND ABBREVIATIONS

4IR	Fourth Industrial Revolution
AGM	Annual general meeting
AMMSA	Association of Mine Managers South Africa
ARWU	Academic Ranking of World Universities
CDIO	Conceive, design, implement, operate
CSIR	Council for Scientific and Industrial Research
DST	Department of Science and Technology
EBIT	Faculty of Engineering, Built Environment and Information Technology
ELSA	English Language Skills Assessment
HOD	Head of Department
IIT	Interactive immersive technology
KPI	Key performance indicator
MASUP	Mining Alumni Society of the University of Pretoria
MCSA	Minerals Council South Africa
MEESA	Mining Engineering Education South Africa
MELA	Mining Engineering Leadership Academy
METF	Minerals Education Trust Fund
MHSC	Mine Health and Safety Council
MMP	Mandela Mining Precinct
MQA	Mining Qualifications Authority
MRRC	Mining Resilience Research Centre
NDP	National Development Plan
PGM	Platinum group metals
SACMA	South African Colliery Managers' Association
SAIMM	Southern Africa Institute of Mining and Metallurgy
SAMERDI	South African Mining, Extraction, Research, Development and Innovation
SANIRE	South African Institute of Rock Engineering
SIMRAC	Safety in Mines Research Advisory Council
SOMP	Society of Mining Professors
TMS	Tuks Mining Society
UP	University of Pretoria
Wits	University of the Witwatersrand
VR	Virtual reality
VUCA	Volatility, uncertainty, complexity, ambiguity

Annual Report of the Department of Mining Engineering at the University of Pretoria for the period 1 July 2018 to 30 June 2019

Prof Sunil Maharaj, Dean of EBIT

MESSAGE FROM THE DEAN

In recent months, there has been a renewed interest in the South African mining industry. This notion was particularly prevalent in the 2018 Investing in Africa Mining Indaba, where discussions considered how the mining industry reaching its full potential could help restore the South African dream. Stakeholders throughout the industry are driving the idea that "mining matters" for a sustainable economic future in South Africa.

The Faculty of Engineering, Built Environment and Information Technology (EBIT) at the University of Pretoria (UP) participates in the global mining arena through its multidisciplinary approach to research and innovation. Central to this is the Department of Mining Engineering and its Mining Resilience Research Centre (MRRC).

The MRRC facilitates interdisciplinary research within the Faculty's departments and the broader University that are engaged in mining-related research. Its flexible contract research model also allows for wider collaboration among other faculties in the University and players in the broader mining sector.

The Department actively collaborates with stakeholders such as the Minerals Council South Africa (MCSA), the Department of Science and Technology (DST) and the Mine Health and Safety Council (MHSC). In this regard, the MRRC has been established as the key centre to coordinate all MHSC research within the University, as well as research and other activities related to the newly established Mandela Mining Precinct (MMP). It is also generously supported by the Minerals Education Trust Fund (METF).

To ensure that the Faculty remains relevant in the mining space, the Department of Mining Engineering continues to increase its visibility on the global stage through collaborative research, engage in pertinent research initiatives through the MRRC and produce work-ready mining engineers. This is a significant step in the Department's objective of increasing its international stature and competitiveness, and subsequently its place in the global arena. It signifies a turning point for mining research and education at UP. The Faculty appreciates the wonderful support it has received from the mining industry and various state-owned entities over the years. We are convinced that, through such partnerships and initiatives, great outcomes must prevail.

Prof Sunil Maharaj
Dean: Faculty of Engineering, Built Environment and Information Technology

UNIVERSITY OF PRETORIA

TOP 100

FOR MINING AND MINERAL ENGINEERING IN THE WORLD IN 2019 ARWU SUBJECT RANKINGS

TOP 0.5%

OF ENGINEERING SCHOOLS IN THE WORLD IN 2018 ISI ESSENTIAL SCIENCE INDICATORS

Prof Ronny Webber-Youngman, Head of Department (HOD): Mining Engineering

EDUCATING AND LEADING MINING ENGINEERS TO BECOME **IMAGINEERS**

VISION

To be a leading, research-intensive mining engineering department in Africa, recognised internationally for its quality, relevance and impact, and for developing people, creating knowledge and making a difference locally and globally.

MISSION

To educate and lead mining engineering students 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.

STRATEGIC GOALS:
GUIDING OUR LONG-TERM TRAJECTORY

To be a leading, research-intensive department

To pursue excellence in teaching and learning

To be recognised continuously for the quality of graduates delivered

To strengthen the Department's national and international profile through the establishment of sound, sustainable business and other relationships

To become financially independent in terms of the growth strategy of the Department

MESSAGE FROM THE HOD

The Department and I are pleased to showcase the exceptional achievements that have characterised the period 2018/19. This is our second annual review, and we are very proud of the outcome.

#UPMiningMatters

In no uncertain terms, it has become clear that, in South Africa, mining does indeed matter. This notion has informed the Department's period under review and has been adopted as the theme of the 2018/19 Annual Review. In this regard, the Department has embarked on the ***#UPMiningMatters*** drive.

The Department plays a significant role in mining teaching, learning and research at the University and Pretoria, and engages in cross-disciplinary work with numerous related departments and faculties. To facilitate this, the Mining Resilience Research Centre (MRRC) was established in the Department in 2016. This formed part of the Department's long-term strategy to become a world leader in mining research for practical implementation. The overarching goal is 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 postgraduate education and research. In this regard, the Department is actively involved with the Mine Health and Safety Council (MHSC) and the Mandela Mining Precinct (MMP).

The Department aims to become a world leader in mining research for practical implementation. The overarching goal is 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.

One of the key aspects that the Department intends to actively pursue in the immediate future is the improvement of its representation on international ranking systems. These play a significant role in determining an academic department's relevance in and contribution to the local and international mining environment. They are used to evaluate overall performance and give a clear indication of a department's status in the international context.

The QS World University Rankings, for example, is a ranking system made up of four major components: academic reputation, citations per paper, H-index citations and employer reputation. To improve the Department's position in this prestigious subject ranking, it intends to elevate the initiative of its MRRC, which is a strategic intervention that has, at its core, the integration of research emanating from various UP faculties and departments that are undertaking mining research. The purpose is to contribute to solutions to complex mining problems, not only locally, but also internationally.

The academic reputation of any department relates to the quality of its staff and related research experts' contribution on a global scale. This directly implicates potential improvement in citations per paper, as well as the overall H-index citations of the Department. Our internationalisation drive will thus become a key aspect of exploration in the immediate future in order to elevate our international visibility as an academic institution of note.

Improved employer reputation perception is also a key aspect in the pursuit of improved rankings. The Department's leadership and employability initiatives are drivers of this goal, and its continuous improvement is something the Department is actively exploring.

Another significant ranking system is the Academic Ranking of World Universities (ARWU) subject rankings. It uses the following criteria to determine its overall ranking of academic institutions: quality of education, quality of faculty, research output and per capita academic performance of the institution. The Department is very proud to announce that UP has been ranked in the top 100 universities for mining and mineral engineering in the world in the recent ARWU rankings, based on the Web of Science data. The Department's strategic focus for the future is to improve the position of UP's mining research in the ARWU rankings and to feature in the QS ranking as well.

We need a special drive to make our objective of increasing our rankings on the world stage a reality.

Our visibility drive is rooted in the ***#UPMiningMatters*** initiative. The Department has many success stories that deserve recognition on wider platforms than are currently utilised. The key objective of the ***#UPMiningMatters*** initiative is to showcase our success stories for all to appreciate and share.

In true academic spirit, we believe that improvement does not occur in isolation, but rather by learning from others and having an open mind. In this regard, I will be visiting the Colorado School of Mines later this year to learn how the institution has managed to maintain its position as top QS-ranked mining university.

2018/19 Highlights

The Department had several success stories during 2018/19. It increased its postgraduate student numbers to the highest number ever: 51. This is made up of 36 honours, eight master's and seven PhD students currently registered in the Department. It also aligns with the Department's strategic drive to increase its postgraduate student numbers, which has a direct impact on its research publication output.

As a department, we are continuously increasing our research publications in journals and at conferences. The 2018 academic year is no exception, as illustrated in this review. The challenge that we are embracing, and that we fully support, is to pursue our drive to increase our publications in accredited international journals and cement our academic relationships with other international mining schools.

From a teaching and learning perspective, we have performed a recurriculum exercise to align our activities with the challenges that we face in the next generation of mining. The challenges pertaining to the Fourth Industrial Revolution need to be dealt with in a very different way than has ever been done in the past. More than a decade ago, the Department established a Mining Engineering Leadership Academy (MELA), which we believe is now more important than ever. The ability to deal with up to five different generations of workers in the workforce requires special skills. We are embracing this challenge by equipping our students with various non-technical skills. We believe that this will enhance their ability to deal with the expected complexities in the mining industry that we are already experiencing.

Another initiative that is being launched in the Department is its interactive immersive technology (IIT) drive in teaching in learning. I believe that this will add another dimension to the Department's strategy of delivering quality education.

The "gamefication" of education and training has, at its core, the use of game design elements in a non-game context. The goal of gameful design, furthermore, has the potential of affording motivating, enjoyable experiences that are characteristic of game play in non-gaming contexts.

I am convinced that the future of education (knowledge transfer) and training (applying knowledge) lies in this space, and we will further explore this.

Prof Ronny Webber-Youngman, HOD

The challenges pertaining to the Fourth Industrial Revolution need to be dealt with in a very different way than has ever been done in the past.

In the context of undergraduate research projects, I am proud to say that two of our final-year students, Henko Maritz and Yugen Govender, were placed in the first and second positions, respectively, at the student colloquium of the Southern African Institute of Mining and Metallurgy (SAIMM) in October 2018. These are the South African championships for student projects. As a department, we have always been very competitive in this competition, with the 2018 result being one of our best student achievements in recent years.

We also believe that a major contributor in our success story is the English literacy support drive that has been introduced for our students over the last five years. This programme uses an English Language Skills Assessment (ELSA) tool to establish shortcomings in our students' language proficiency levels. Remedial programmes are then applied, where necessary, throughout their academic careers. This year, we appointed another three postgraduate English tutors to accommodate all the year groups. Through this intervention, various aspects pertaining to English literacy, such as communication in reading comprehension, writing and presenting a research report of a good quality, are covered.

This year, I once again hosted the annual HOD Forum to highlight the Department's past success and future plans for the benefit of our staff and students. It is my firm belief that all the activities the Department has embarked on over the last few years have equipped our students with the necessary non-technical skills to excel in industry, and will continue to do so in the future.

The current number of alumni who are employed at senior executive level in the mining industry in South Africa and abroad is a true testament of the quality of graduates that the Department has produced and will continue to produce in future.

I would thus, once again, like to give credit to my lecturing and support staff, who – in their own unique ways – make a major contribution in educating and leading our students to become imagineers.

Prof Ronny Webber-Youngman
Head of the Department of Mining Engineering
University of Pretoria

DEPARTMENT PROFILE

Since its inception in 1961, the Department of Mining Engineering at the University of Pretoria 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. It is actively involved in the community, and its staff members participate in the activities of professional societies, as well as in expert consultation and other activities in the Faculty.

ACADEMIC OFFERING

Undergraduate students pursue the BEng Mining Engineering degree programme.

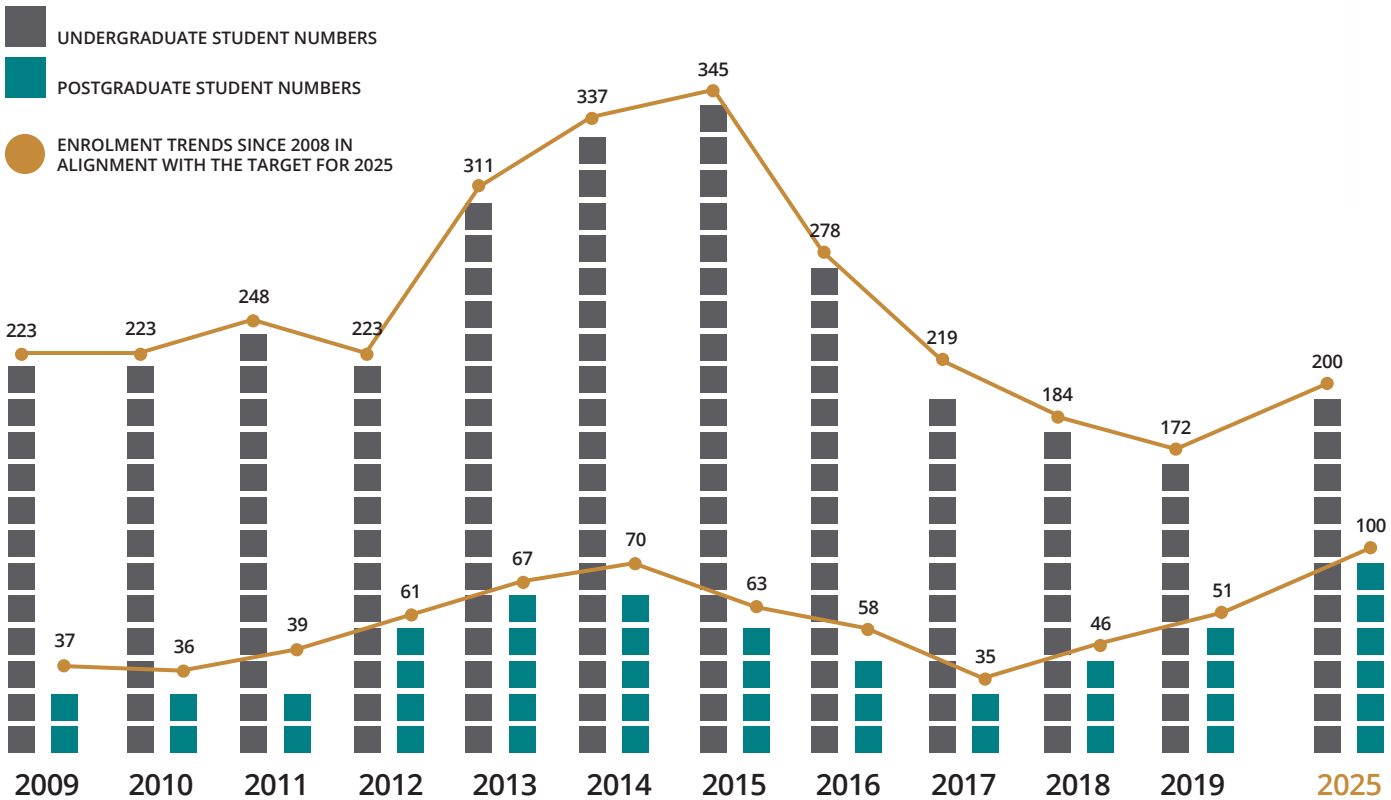
Postgraduate students can pursue honours, master's and doctoral degree programmes in mining engineering and applied science mining.

STRATEGIC INTENT

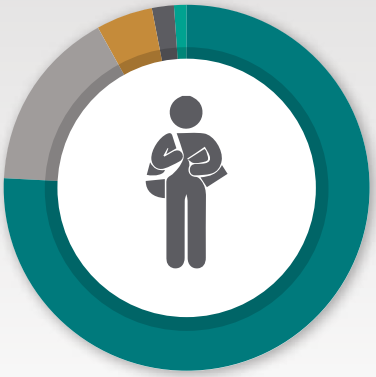
The Department aligns itself with the strategic objectives of the University of Pretoria:

- Enhance access and successful student learning
- Strengthen the University's research and international profile
- Foster and sustain a diverse, inclusive and equitable university community
- Optimise resources and enhance institutional sustainability
- Strengthen the University's responsiveness and impact in society

After several years of significant growth in undergraduate student numbers, followed by a slump in mining student numbers worldwide, it was decided to reduce the Department's first-year intake. Its designed capacity is 50 final-year students, and its strategic intent is to have 200 undergraduate (which, in terms of the current need for mining engineers decreasing worldwide, might be re-addressed in the very near future) and 100 postgraduate students by 2025. This is informed by the current employment trends in the mining industry, which have a direct impact on the number of students who display an interest in pursuing mining engineering as a career. In this regard, we need a paradigm shift in terms of what the future of mining engineering will look like. The Department's strategic intent is illustrated in the figure below.



UNDERGRADUATE STUDENT DEMOGRAPHICS



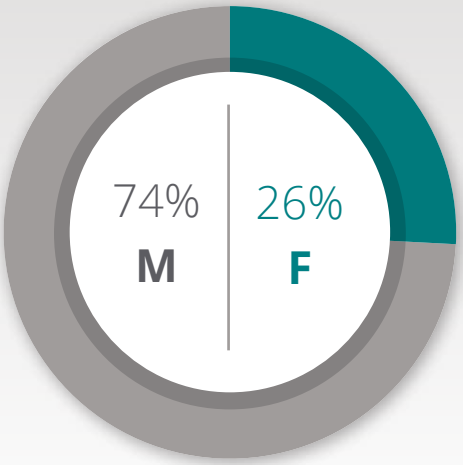
01 **Black (76%)**

02 **White (16%)**

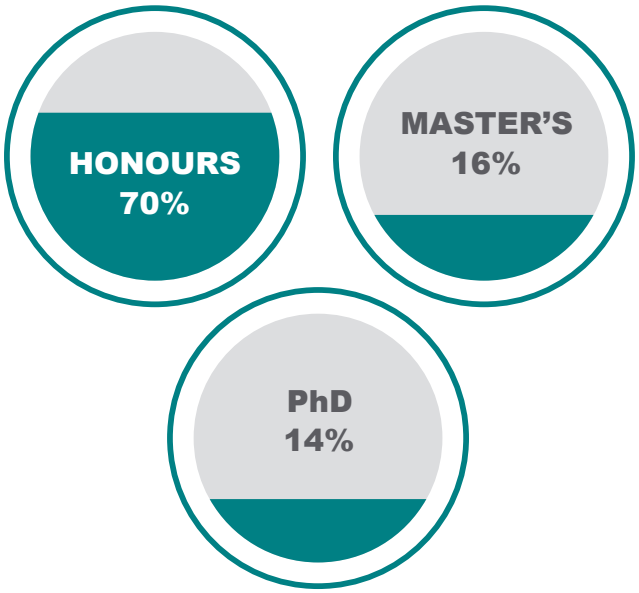
03 **International (5%)**

04 **Indian (2%)**

05 **Coloured (1%)**



POSTGRADUATE COMPONENT



STAFF COMPONENT

Permanent staff: Academic support

06

Permanent staff: Administration

02

Contracted-in staff: Academic support

18

Contracted-in staff: Administration

04

*The Department is supported by **5 honorary or extraordinary professors**. These seasoned academics assist the Department with the supervision of postgraduate research, specifically as it relates to ventilation engineering, rock engineering, explosives engineering and mining business. They are Prof Con Fauconnier, Prof Bharath Belle, Prof Jan du Plessis, Prof John Napier and Prof William Spiteri.*

STUDENT SUCCESS

*During the period under review, **38 students graduated** from the Department. It is estimated that graduates from UP make up **between 15% and 20% of mining industry graduates**. This year also saw the largest group of master's degree students to graduate from the Department in a single year.*

ALUMNA PROFILE

Vukosi Danisa Baloyi

The Department is proud to associate itself with top students and professionals in mining engineering. It is also focused on driving transformation in the mining research and management sectors. As such, it is an honour to showcase the achievements of Vukosi Danisa Baloyi, the Department's first black female master's graduate.

Danisa is a passionate mining engineer who is willing to learn from anyone, irrespective of their status, and who is not afraid of hard work and dedication. During the course of her academic career, she has authored two published books and served as a final-year research supervisor. She was also invited to speak at the Johannesburg Mining Indaba and present her final-year project at the SAIMM colloquium.

During her undergraduate studies, Danisa was named best third-year student in Geology and top second-year Mining Engineering student. She also participated in the Sasol Engineering Leadership Academy. In addition to these achievements, Danisa is the co-founder of the We All Win Foundation, a non-profit organisation focused on empowerment, inspiration and mentorship.

Master's graduates at the April 2019 graduation ceremony (listed below with their dissertation titles from left).

2018/19 MASTER'S GRADUATES DISSERTATIONS

Vukosi Danisa Baloyi, MEng (Mining Engineering)
The development of a mining method selection model through a detailed assessment of multi-criteria decision methods

Anton Wynand Bester, MEng (Mining Engineering)
An investigation into using remotely piloted aircraft system technology for decision making regarding block lifecycle activities in surface mining

Wolter Willem de Graaf, MEng (Mining Engineering)
A preliminary evaluation of a hydraulic splitting cylinder as a means of breaking rock in a deep-level mine

Philani Larrance Ngwenyama, MEng (Mininig Engineering)
A critical investigation into missing persons in underground mines and the related tracking technology

STAFF PROFILE

DEAN

Prof Sunil Maharaj

HOD

Prof Ronny Webber-Youngman

The Department is home to exceptional academic and support staff. To ensure sustainability, capacity is expanded through contract staff. This forms part of the Department's succession planning. Apart from their normal lecturing and research activities, staff members actively take responsibility for initiatives such as the Department's marketing and communication drive, its student wellbeing drive, its English competency drive and its non-technical skills drive.

ASSISTANT

Daleen Gudmanz

FINANCE

Jeritha Maphoto

INSTRUCTIONAL DESIGNER AND POSTGRADUATE COORDINATOR

Marietha Hicks

DEPARTMENT ADMINISTRATION

Abea Kgatshe

MARKETING AND COMMUNICATION

Wolter de Graaf

Marietha Hicks

STUDENT ADMINISTRATION, TEACHING AND LEARNING

Jannie Maritz

Marietha Hicks

DEPARTMENT PROJECTS

Dr Bertie Meyer

VR CENTRE

Jannie Maritz

Abea Kgatshe

Zander Beest van Andel

In addition to its everyday functions, the Department takes pride in developing its staff members to reach their full potential. During the period under review, its staff component included ***7 young developing*** *academics.*

LEADERSHIP: Dr Johann Uys

ENGLISH LITERACY: Isabella Venter

SHORT COURSES

All lecturers

CONTRACT AND CONSULTING STAFF

All lecturers

MRRC

Prof Francois Malan (Director)

RESEARCH CHAIRS

HARMONY CHAIR IN ROCK ENGINEERING AND NUMERICAL MODELLING: Prof Francois Malan

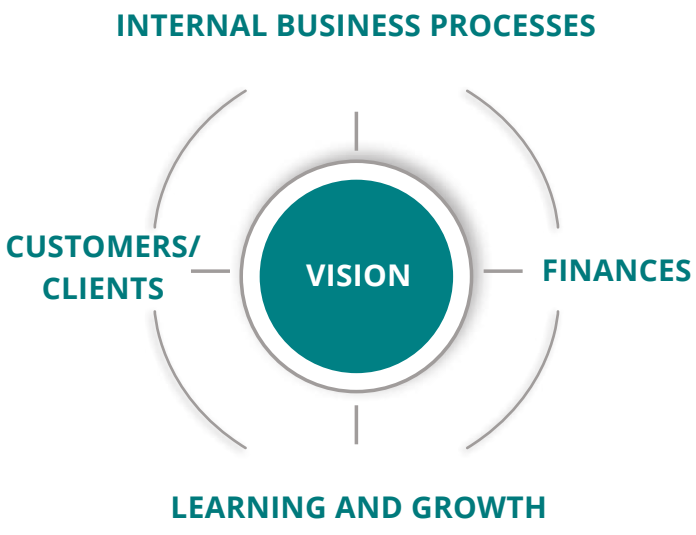
AEL INTELLIGENT BLASTING CHAIR IN INNOVATIVE ROCK-BREAKING TECHNOLOGY: Prof William Spiteri

MANAGEMENT ACTIVITIES

The Department follows a balanced scorecard management system approach in terms of its related responsibilities.

These responsibilities include the following:

- ***Internal business processes***
  Undergraduate and postgraduate education, student wellbeing, and teaching and learning
- ***Finances***
  Management and budgetary control
- ***Learning and growth***
  Academic and contract research, the Kumba Virtual Reality (VR) Centre for Mine Design and the Mining Resilience Research Centre
- ***Accountability to customers/clients***
  Industry representation, community engagement, and marketing and communication activities



Visual representation of the Department's balanced scorecard management system approach incorporating its related responsibilities.

FUNDING STRATEGY

The presentation of short courses in conjunction with Enterprises UP still forms an important part of the Department's funding strategy as it relates to its third-stream income activities. These courses would not have been possible without the support of industry. They furthermore enable the Department to supplement its Development Fund. Income derived from research chairs and short courses forms the bulk of the Department's third-stream income.

RESEARCH PROFILE

A renewed effort was made to increase the research output of the Department during the period under review. It increased the number of refereed papers in high-impact international journals and appointed industry experts on a part-time basis to conduct cutting-edge research and to supervise postgraduate students. Industry specialists were involved in a number of designated academic programmes and research-related activities.

As part of a process to increase the quality of research projects, the Department made Research Methodology as a subject a compulsory part of postgraduate students' master's and PhD studies for those students for whom it would be beneficial.

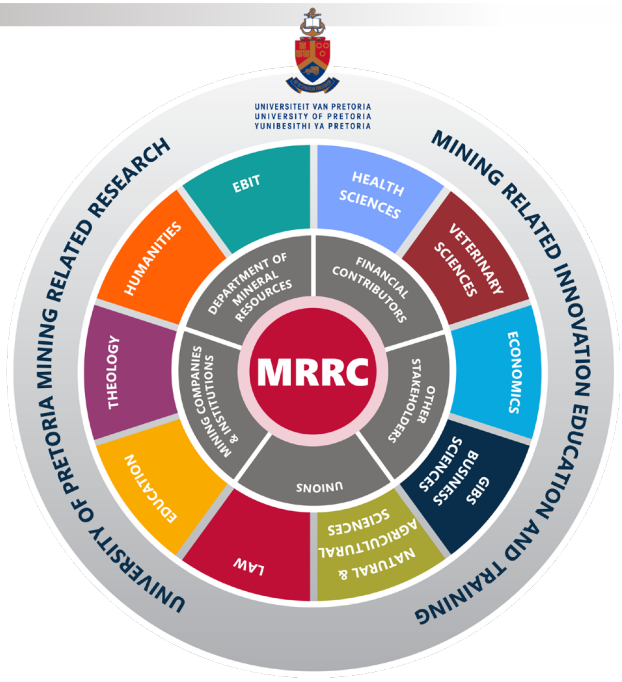
The number of registered postgraduate honours, master's and PhD students in the Department increased in 2019 to a total of 51, with four students graduating with a master's degree at the same time. This is the largest group of master's degree students to graduate from the Department in a single year. The Department intends to expand its research capacity to at least 100 postgraduate students by 2025, of whom it is envisaged 30% will be full-time students. The Department's growth strategy is aimed at increasing its postgraduate numbers, while sustaining undergraduate enrolments at approximately 200 students. This target will be reviewed in terms of future needs. This strategy was well received by members of the Department's Advisory Council, who agreed that the complex challenges in the mining industry today need to be dealt with through an increase in postgraduate research activities.

MINING RESILIENCE RESEARCH CENTRE

Many collaborative and cross-cutting contract research initiatives, coordinated by the Department's Mining Resilience Research Centre (MRRC), took place during the period under review. Activities within the MRRC are managed by Prof Francois Malan (Director), who has vast experience in contract research.

The MRRC continued its excellent relationship with the Mine Health and Safety Council (MHSC). A Memorandum of understanding was signed between the University of Pretoria and the MHSC to establish the MRRC as a Centre of Excellence. It would therefore coordinate all MHSC research within the University. Two MHSC projects were subsequently conducted in 2018 and funding was secured for a third project to be completed in 2019. These are the following:

- *Feasibility assessment of reducing diesel particulate matter exposure by replacing and/or converting all Tier 0 with Tier 2 or Tier 3 engines* (2018)
- *Developing mining illumination standards for mobile equipment operating in open pit and underground mines in the South African mining industry* (2018)
- *Determining good ledging practices and developing animated video training material based on good ledging practices* (2019)



Other research projects that were secured during the period under review include a study of thin sprayed lines for Lonmin Platinum, engineered load pre-stressing devices for Impala Platinum and the numerical modelling of pillar behaviour for Northam Platinum. Another project, the mechanised drill and blast project, is closely related to one of the Department's main research themes. Proposals for the development of reef boring and rapid access technology will also be pursued in the following year.

Due to the fact that the Centre does not currently directly employ any administrative staff, it is anticipated

that Enterprises UP will play a greater role in 2020 in assisting with administrative duties, particularly since it has a significant mining focus. This will provide an efficient solution to the administrative duties required in the MRRC.

As part of its commitment to collaboration with industry, the Department was closely involved with the South African Mining, Extraction, Research, Development and Innovation (SAMERDI)/Mandela Mining Precinct (MMP) initiative, funded by the Minerals Council South Africa (MCSA) and the Department of Science and Technology (DST). This is a collaborative initiative between UP, the University of the Witwatersrand, the University of Johannesburg, the University of South Africa and the Council for Scientific and Industrial Research (CSIR).

It is funded by the DST, with planned funding by the Department of Trade and Industry (the dti) once the projects reach sufficient technology readiness levels for commercialisation.

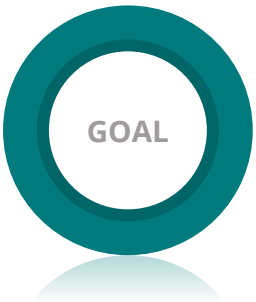
The following research projects were undertaken in 2018:

- *Mechanisation of gold and platinum group metals (PGM) mines using drilling and blasting – Phase 1*
- *Non-explosive rock-breaking of gold and PGM mines – Phase 1*
- *Real-time information management systems – Phase 1*
- *The longevity of current mining through best practice analysis – Phase 1*
- *Real-time information management systems for underground mining – Phase 1*

External research funding through contract research work undertaken by the MRRC within SAMERDI/MMP and the MHSC will further assist in maintaining the Department's current research momentum. It is foreseen that the Department will again be successful in attracting external research funding through the MHSC's Safety in Mines Research Advisory Committee (SIMRAC) and the Centre of Excellence respectively (under the MHSC), even though the mining environment is extremely constrained at present.

In the long run, the Department intends to focus its research on activities related to mine layout design, mechanisation and new mining methods to ensure the sustainability of the South African mining industry. Its current research focus is on the following specific areas:

- Mechanisation and automation
- Rock-breaking and explosive engineering
- Rock-cutting
- Management and leadership
- Risk management
- Mine ventilation engineering
- Rock engineering



Focus on activities related to mine layout design, mechanisation and new mining methods to ensure mining sustainability.

HARMONY CHAIR IN ROCK ENGINEERING AND NUMERICAL MODELLING

The support of Harmony Gold for the Chair in Rock Engineering and Numerical Modelling continued during the period under review. The Chair focused on directed research into specific rock engineering problems and the associated solutions. This Chair is now in the final year of a three-year contract that ends in December 2019. Harmony has indicated that it will support the continuation of the Chair until the end of December 2022. The Chairholder is Prof Francois Malan.

Research undertaken in this Chair includes developing new mine design criteria for deep gold mines, exploiting remnants in old mines and a study of mining rate. Research outcomes in the Harmony Chair for 2018/19 include the following:

- Developing a numerical code to simulate mining rate
- Calibration of the numerical mining rate model
- Triangular element formulation for the limit equilibrium model
- Formulation of a theoretical limit model
- Evaluation of a proposed partial element fracturing algorithm
- New design criteria for remnants

INDUSTRY-WIDE ROCK ENGINEERING RESEARCH

A new focus in the Department was placed on rock engineering research with the full-time appointment of Prof Francois Malan in 2018. A key aspect of this research is to develop new design criteria and layouts for hard rock mines to ensure their future sustainability. Improved formulae and methods for designing hard rock pillars will also be investigated. Close collaboration was established with the mining industry with regard to this research, especially with Northam Platinum, Lonmin Platinum, Impala Platinum and Harmony Gold.

The intention of this research initiative is to establish the necessary critical mass to develop focused research areas in rock engineering. A number of postgraduate students have been assembled to assist with this research.

Current projects related to pillar behaviour, pillar layout and design include the following:

- Pillar shape
- Time-dependent spalling of pillars
- Gold remnants and pillars: new design criteria
- Undersized coal pillar simulations
- Pillar strength in chrome mines
- The effect of weak layers on pillars
- Booysensdal experimentation on pillar size reduction

Members of the AEL Intelligent Blasting Advisory Board.

NEW

MURRAY & ROBERTS CHAIR IN INDUSTRY LEADERSHIP 4.0

Murray & Roberts has committed its support to a new Chair in Industry Leadership 4.0, which will be launched on 25 November 2019, with the inception date of activities in the Chair as from 1 January 2020. It will be funded for a three-year term until the end of 2022. The purpose of the Chair is to provide specialised skills and capacity building that are essential to the implementation of optimised systems related to the Fourth Industrial Revolution through defined leadership strategies.

The following proposed initiatives will form part of this Chair:

- Short-term research related to technology adoption and implementation in the industry
- Short courses and workshop interventions to provide delegates with sufficient levels of personal readiness; guide leaders to become strategists and implementers of new technologies; do global benchmarking in Industry 4.0 senior leaders' acceptance of technology principles; and steer change management
- Long-term research with specific leadership adoption in a changing industrial world, with the purpose of preparing leaders for the new high-technology landscape
- Training and continuing professional development initiatives that will make use of the Department's virtual reality facilities

The establishment of this Chair illustrates the Department's innovative approach to grooming future leaders on a broader scale in the engineering and construction industry: taking account of the exponential advancement of technology in a volatile, uncertain, complex and ambiguous (VUCA) environment. By understanding the importance of leadership in the implementation of new technologies, the Department aims to develop introspective leaders, who will continually challenge and develop their analytical ability and leadership effectiveness. This will contribute to their companies becoming more competitive and sustainable in an industry that is being transformed by high-tech innovation and disruptive technologies. The Chair will collaborate with the Department's Mining Engineering Leadership Academy.

AEL INTELLIGENT BLASTING CHAIR IN INNOVATIVE ROCK-BREAKING TECHNOLOGY

The support of this Research Chair, which was established in 2018, is in the second year of a three-year contract that ends in December 2020. Discussions are already in place to ensure that this agreement will be continued beyond 2020. The Department has identified the importance of developing postgraduate students in this field. The Chairholder is Prof William Spiteri.

During 2018, the first research study in the Chair examined the safe clearance distance implemented at Glencore's Goedgevonden Mine in Mpumalanga.

Research outcomes in the AEL Intelligent Blasting Chair in Innovative Rock-breaking Technology for 2018/19 include the following:

- The determination of safe blast clearance radii for blasting operations at Glencore coal mines in the Witbank area
- Developing a method to measure flyrock effectively and quantitatively with the intention of eventually optimising flyrock prediction models
- A virtual reality visualisation project
- The design and development of game-based training and assessment solutions to equip new blasters with problem-solving skills

SUPPORTING INDUSTRY WITH COLLABORATIVE CONTRACT RESEARCH

The Department was involved in the following collaborative contract research activities during the period under review:

- *Establishing a test and simulation capability and standard verification methods to evaluate collision management systems (with Mechanical Engineering)*
- *Developing an underground and surface communication system (with Electrical, Electronic and Computer Engineering)*
- *Rock mass condition assessment tools (with Mechanical Engineering)*
- *The mechanisation of gold and PGM mines using drilling and blasting – Phase 1*
- *Non-explosive rock breaking in gold and PGM mines – Phase 1*
- *Real-time information management systems – Phase 1*
- *The longevity of current mining through best practice analysis – Phase 1*
- *Real-time information management systems for underground mining – Phase 1*
- *Glencore Waterval East collision management system: technology assessment*

INTERNATIONAL COLLABORATION

One of the Department's key strategic initiatives is to be recognised internationally as a leading, globally relevant research department of mining engineering. It has signed an agreement with Camborne School of Mines at the University of Exeter in the UK to increase the collaboration potential among researchers with similar technical subject knowledge and skills, and to foster the idea of international co-publication.

The Department intends to develop a similar arrangement with the Colorado School of Mines in Denver, Colorado, which is the top-ranked mining school in the world. The knowledge gained from the proposed visit to Colorado will be used as a benchmark in aligning the Department's objectives and improving its own ranking.

RESEARCH OUTPUTS (2018)

Journal articles

De Graaf, W. & Spiteri, W. 2018. A preliminary qualitative evaluation of a hydraulic splitting cylinder for breaking rock in deep-level mining. *Journal of the Southern African Institute of Mining and Metallurgy*, 118(8): 891–897.

Haupt, M. & Webber-Youngman, R. 2018. Engineering education: An integrated problem-solving framework for discipline-specific professional development in mining engineering. *Journal of the Southern African Institute of Mining and Metallurgy*, 118(1): 27–37.

Esterhuyse, J.C. & Malan, D.F. 2018. Some rock engineering aspects of multi-reef pillar extraction on the Ventersdorp Contact Reef. *Journal of the Southern African Institute of Mining and Metallurgy*, 118(12): 1285–1296.

Malan, D.F. & Napier, J.A.L. 2018. A limit equilibrium fracture zone model to investigate seismicity in coal mines. *International Journal of Mining Science and Technology*, 28: 745–753.

Malan, D.F. & Napier, J.A.L. 2018. Rockburst support in shallow-dipping tabular stopes at great depth. *International Journal of Rock Mechanics and Mining Sciences*, 112: 302–312.

Napier, J.A.L. & Malan, D.F. 2018. Simulation of tabular mine face advance rates using a simplified fracture zone module. *International Journal of Rock Mechanics and Mining Sciences*, 109: 105–114.

Uludag, S. & Pasch, O. 2018. Optimisation of the load-and-haul operation at an opencast colliery. *Journal of the Southern African Institute of Mining and Metallurgy*, 118(5): 449–456.

Conference papers

Couto, P.M. 2018. The effect of mining layout, regional pillars and backfill support on delaying expected shaft deformation at Bambanani mine. Proceedings of Eurock 2018, Geomechanics and Geodynamics of Rock Masses, 22–26 May 2018, Saint Petersburg, Russia, vol. 1, pp. 235–240.

Hartzenberg, A.G. & Du Plessis, M. 2018. Investigating the mechanism contributing to large scale structurally driven hangingwall instabilities on the UG2 reef horizon. Proceedings of Eurock 2018, Geomechanics and Geodynamics of Rock Masses, 22–26 May 2018, Saint Petersburg, Russia, vol. 1, pp. 293–297.

Du Plessis, M. & Malan, D.F. 2018. The effect of rock mass stiffness on crush pillar behaviour. Proceedings of Eurock 2018, Geomechanics and Geodynamics of Rock Masses, 22–26 May 2018, Saint Petersburg, Russia, vol. 1, pp. 871–876.

Maritz, J. & Wagner, H. 2018. The need for formal rock engineering expertise in deep mining. Proceedings of Eurock 2018, Geomechanics and Geodynamics of Rock Masses, 22–26 May 2018, Saint Petersburg, Russia, vol. 2, pp. 1047–1051.

Maritz, J. & De Beer, J. 2018. Using games to teach support design. Proceedings of the 10th Asian Rock Mechanics Symposium (ISRM International Symposium 2018), 29 October–3 November 2018, Singapore, pp. 1–10.

Ngwenyama, P. & De Graaf, W. 2018. A trade-off between the bord collapse and the bord-and-pillar collapse blasting techniques in opencast pillar mining operations. Proceedings of 4th Young Professionals Conference (Creating a sustainable African minerals industry through applied innovation), 18–19 September 2018, Sandton, South Africa, pp. 123–136.

Pretorius, L. & Uludag, S. 2018. System thinking, a modelling tool for managing change in a mining environment. Proceedings of the 2018 IEEE Technology and Engineering Management Conference (TEMSCON 2018), 28 June–1 July 2018, Evanston, IL, pp. 1–7.

RESEARCH ABSTRACTS

The following abstracts summarise research published in accredited journals and illustrate the Department's contribution to knowledge on mining-related topics.

W de Graaf and W Spiteri

A preliminary qualitative evaluation of a hydraulic splitting cylinder for breaking rock in deep-level mining (*Journal of the Southern African Institute of Mining and Metallurgy*)

Hydraulic rock-splitting cylinders have proved successful in numerous civil and construction applications. The purpose of this study was to conduct a preliminary qualitative evaluation of the applicability of the hydraulic splitting cylinder in deep-level mining with the aim of recommending equipment modifications and operational practices. The particular instrument used in the study was the DARDA® hydraulic splitter.

Conventional drill-and-blast practice in deep-level mining often impacts adversely on the immediate environment. Alternatives are periodically sought for efficient, continuous and safe rock-breaking in situations where conventional blasting is undesirable. Mining companies, equipment manufacturers and research institutions have conducted a considerable amount of investigation work on numerous methods of non-explosive mining, including the use of the hydraulic rock-splitter.

Several trials were conducted underground. The most challenging aspect of mechanical rock-splitting is to create a second free face in the stope. The trials evaluated four different "cut" layouts to achieve this objective. The trials highlighted the limits of the equipment in its current phase of development, as well as the importance of quality drilling in terms of collaring the hole, hole length and directional accuracy. In the presence of a second free face, the splitter becomes far more effective. The unit is simple in design and is easily integrated into existing mining operations. It does not require a technically skilled workforce or expensive maintenance either.

Rock-breaking by using a rock splitter could have a place in niche applications in an underground mining operation, with some equipment modifications and further development of the process to establish a free-breaking face. General operational difficulties experienced underground during the trials are summarised and possible solutions recommended.

Keywords: *Rock-breaking, mechanical splitting, hydraulic splitter*

M Haupt and R Webber-Youngman

Engineering education: An integrated problem-solving framework for discipline-specific professional development in mining engineering (*Journal of the Southern African Institute of Mining and Metallurgy*)

This article is based on the premise that the purpose of engineering education, in general, is to deliver engineering practitioners who are intellectually capable of identifying, structuring and solving complex problems, and that solving engineering problems is systemic. The solutions to problems are viewed as objects, tools, processes and systems. The purpose of this article is, however, to specifically explore some of the aspects of the intangible world of mining engineering from a generic problem-solving perspective, which would also be applicable to any other engineering discipline. This is done by focusing on higher-order intellectual processes when processing information in the problem-structuring and problem-solving space. As such, this article builds on a previous study in which the intangible world of the mining engineer was identified as worth investing in. The article begins by briefly reviewing the complexity of the mining engineering problem-solving space and the background and role of a generic cognitive approach to problem solving in the mining engineering curriculum at the University of Pretoria (UP). Several dimensions of extended cognitive processing are then detailed, explaining why the early phases of problem solving are difficult to learn, and more difficult still to teach. An outline is given of the classification of types of mining engineering problems, and its determinant role in the dynamics of information processing. Conceiving, designing, implementing and operating (CDIO) as an overarching engineering methodology is discussed, together with the subsequent mapping of cognitive phases onto CDIO stages. Finally, the researchers pose an open research question that seems important to answer in order to identify the best pedagogical practices for improving problem-solving capabilities not only in mining engineering, but also in other engineering disciplines.

Keywords: *Extended cognition, information processing, problem solving, systems thinking*

JC Esterhuyse and DF Malan

Some rock engineering aspects of multi-reef pillar extraction on the Ventersdorp Contact Reef (*Journal of the Southern African Institute of Mining and Metallurgy*)

Mining in the Carletonville area of the Witwatersrand Basin predates 1934. Owing to the depletion of higher-grade ore, the current activities focus increasingly on the extraction of lower-grade secondary reefs, as well as remnant extraction. Of particular interest is multi-reef remnant extraction. Numerical modelling was conducted to investigate some rock engineering aspects of remnants being understoped on a secondary reef horizon. An analysis of the stress evolution in the middling between two reef horizons indicated that a zone of high major and low minor principal stress develops between the two reefs. This indicates a high risk of violent shear failure. Some pillars were nevertheless successfully understoped in the past and a study was conducted to better understand this phenomenon. An "extended" energy release rate concept introduced by Napier and Malan (2014) proved to be useful for investigating this problem. It was found that bedding planes and lithology appear to play a role in the stable dissipation of energy in multi-reef remnant geometries. The study indicated that the stope convergence and the various energy components are affected by the presence, position and properties of a bedding plane. The energy solutions are complex and sometimes counterintuitive. Care should be exercised when modelling specific cases. The modelling was nevertheless valuable as it indicated that energy dissipated on weak layers may reduce the risk of violent failure in a multi-reef mining scenario. Additional work is required to investigate if crushing on the reef plane plays a prominent role when mining these remnants.

Keywords: *Deep-level mining, remnant extraction, understoping, multi-reef mining, energy dissipation, numerical modelling*

DF Malan and JAL Napier

A limit equilibrium fracture zone model to investigate seismicity in coal mines (*International Journal of Mining Science and Technology)*

This paper explores possible synergies between techniques used to minimise seismicity in deep South African gold mines and their applicability to control coal bumps. The paper gives a summary of the techniques used in deep gold mines and a critical appraisal if these are useful in coal mines. The techniques typically include control of mining rate, preconditioning, optimisation of extraction sequences and centralised blasting. Of particular interest to the coal bump problem is an experimental limit equilibrium fracture zone model implemented in a displacement discontinuity code. This was recently developed for the gold mines to enable the interactive analysis of complex tabular mine layout extraction sequences. The model specifically accommodates energy dissipation computations in the developing fracture zone near the edges of these excavations. This allows the released energy to be used as a surrogate measure of ongoing seismic activity and addresses a number of the weaknesses in the traditional use of this quantity as a criterion for the design of seismically active layouts. This paper investigates the application of the model to a hypothetical coal longwall layout and the specific problem of coal bumps.

Keywords: *Coal bumps, limit equilibrium model, mining rate, seismicity*

DF Malan and JAL Napier

Rockburst support in shallow-dipping tabular stopes at great depth *(International Journal of Rock Mechanics and Mining Sciences)*

This paper investigates the unique problems associated with the design of rockburst support for shallow-dipping tabular excavations. These designs are particularly problematic when the stoping width is very small. In steep dipping ore bodies, the layouts and mining methods can be selected to ensure that miners never enter the stopes. Only the access drives need to be protected by rockburst-resistant support. In shallow-dipping ore bodies, this problem is more difficult as miners enter the stopes and the entire hanging wall needs to be supported. A simple analytical model is used to investigate the implications for support design as a result of the convergence associated with the tabular geometry and the possibility of rocks being ejected during a rockburst. This illustrates that a support system is required that is initially stiff, but should also be yieldable to survive the convergence in the back areas. By trial and error, the historic support solutions in South African gold mines evolved into a system of timber packs and elongates to meet these requirements. When considering the three accepted key functions of modern rockburst support methodology – reinforce, retain and hold – the typical support design for these shallow-dipping ore bodies does not meet all these requirements. The rock is highly fractured and fall-outs occur between roofbolts during rockbursts as areal support is difficult to implement. Steel mesh is not used as it is often destroyed during cleaning operations. Solving this problem is of critical importance to ensure the viability of deep South African gold mines in the future.

Keywords: *Rockburst support, tabular stope, areal support, energy absorbing support*

JAL Napier and DF Malan

Simulation of tabular mine face advance rates using a simplified fracture zone module *(International Journal of Rock Mechanics and Mining Sciences)*

This paper describes a method to determine the time-dependent stability of the fracture zone near the edges of tabular excavation layouts when different mining rates and face advance increment lengths are scheduled. Some analytic properties of the proposed time-dependent fracture zone evolution model are presented, initially for a simplified mining geometry. The implementation of the model in a general tabular layout setting is described next, including a novel scheme to allow for partially fractured elements. The reef plane stress distribution in the fracture zone is solved using a fast-marching method that is coupled to a displacement discontinuity solution of the excavation and fracture zone deformations. The numerical scheme is illustrated by considering the extraction of a hypothetical deep-level mining layout. The sensitivity of the results to changes in the mining rate schedule and the face advance step size are discussed. Further extensions to the solution scheme are noted.

S Uludag and O Pasch

Optimisation of the load-and-haul operation at an opencast colliery *(Journal of the Southern African Institute of Mining and Metallurgy)*

The current coal-mining climate is characterised by coal price volatility, political instability, high labour costs and increasing operational costs. This is exacerbated by a steady decline in the growth of global coal demand due to the increased use of alternative and renewable fuels in the energy industry. Locally, the overall mining cost inflation indices show a yearly increase of 2% over the national consumer inflation rate. In order for coal mines to survive and mine profitably, they need to capitalise on the opportunity to improve their productivity and focus on one factor they can control: operational efficiency. Increasing productivity is one of the key drivers to counter diminishing profit margins. Increasing production effectively reduces operating costs. However, the emphasis should not only be on increasing output with the same input, but increasing the output while decreasing the input, and ultimately adding optimum value to current resources. Research shows that an increase in production will ultimately decrease the operation's unit cost, especially fixed costs.

In this study a load-and-haul fleet optimisation approach has been used to identify the opportunities for operational improvement at an open-cast colliery. The study combines the results of a literature review, on-site time studies and statistical data analysis in order to determine the best loadertruck fleet combinations for increased production. Several relevant key performance indicators (KPIs) for the evaluation and identification of productivity improvement opportunities were defined during this study. These KPIs are bucket fill factor, loading conditions, loading cycle time, utilisation and deviation from schedule. The priority delays determined by on-site time studies compared to the time book for each delay showed that idle or waiting time by the loaders, face preparation and relocation, and process delays had significant deviations. However, the results showed that this operation is under-trucked, hence optimising the loader-related inputs proved less effective than optimising truck-related inputs. The results indicated that a homogeneous truck fleet consisting of five Caterpillar 789C trucks, combined with a Caterpillar 994K loader, is the most efficient fleet option and will produce 1 455 t/h. The combined optimised effect of each identified KPI of production led to a tonnage improvement opportunity of 5 421 t per shift.

Keywords: *Optimisation, productivity, load-and-haul fleet, KPIs, under-trucked, tonnage improvement opportunity*

LEADERSHIP AND EMPLOYABILITY

MINING ENGINEERING LEADERSHIP ACADEMY (MELA)

The Department of Mining Engineering is aware of the challenges its graduates face in the transition from student to manager and leader. This is particularly relevant in the complex, rapidly changing world of cyber-technology, the Internet of Things and Industry 4.0.

Students who enter the workplace often lack sufficient self-awareness, interpersonal communication skills and the ability to work in multidisciplinary settings and in diverse groups spanning many generations. This led to the establishment, by Head of Department, Prof Ronny Webber-Youngman more than a decade ago, of the Mining Engineering Leadership Academy (MELA) with the aim of grooming students for the workplace.

All final-year Mining Engineering students attend the MELA programme at the start of each year. The programme then extends to the second half of the year, when students are divided into teams of four students each for their Mine Design course. The MELA programme is structured to better prepare students for their careers in the mining industry by creating an awareness of the stewardship of being a Tukkie and a future mining engineering leader. The teams are selected based on psychometric assessments obtained from the DiSC profile (based on determining the personality traits of dominance, influence, steadiness and conscientiousness) and the Myers-Briggs personality profiles. In conjunction with academic performance, commodity and biographic profiles, teams should be as diverse as possible.

MELA concludes in July with a Leadership Week in which students are introduced to the 4.0D™ Leadership Model for Industry 4.0, developed by Dr Johann Uys, a senior lecturer in the Department. In the context of teamwork in the Mine Design course, MELA focuses on working in teams, emotional intelligence and conflict management. At the end of the week, the teams embark on an outward-bound experiential and action learning team-building day to tackle challenges similar to those they may experience in the world of work first-hand. This year, the students attended the day in a bush setting east of Pretoria.

Under the guidance of Dr Uys, seasoned team building facilitators and MELA staff accompanied students to hone their skills. They were constantly made aware of experiential learning applications in the academic programme, as well as vocational preparation and implementation.

The final phase of the leadership programme incorporates contemporary topics relevant to mine design with specific reference to mine closure design, as well as community awareness and responsibility. Four major focus areas in mine design with regard to communities are highlighted: potential resettlement strategies, current town and settlement expansion plans, the balance between re-skilling local residents and importing skills in the form of migrant labour, and ramping up communities for viable post-mining activity. Guest speakers who were invited to address the students included Dr George Maluleka, General Manager: Projects at Kumba Iron Ore, who delivered a presentation on the Dingleton resettlement project, and Mr Jan Nel, Director at Shangoni Management Services, who enlightened the students about mine closure, as well as post-mining activities and the rehabilitation of mining sites.

Women in mining also featured prominently during Leadership Week. Two of the Department's female alumni inspired students by recounting how they overcame the challenges women face in the mining industry. Nozipho Dlamini (left) shared her career experience and lessons learned with the students, while Tarusha Moonsamy presented a global outlook, taking students on a tour of her work sites in the USA and Australia.

EMPLOYABILITY

Graduates from the Department of Mining Engineering can be employed in a wide range of companies both locally and internationally. Potential careers include those of rock engineer, mine ventilation engineer, rock-breaking engineer, drill and blast engineer, project engineer, mine planner and environmental engineer.

The mining industry is one of the largest industries in South Africa, producing more than 60 different minerals in over a thousand mines and quarries. Approximately 95% of the Department's graduates from 2017 and 2018 are currently employed in various fields in the minerals sector, as well as in consultancies and financial institutions.

There is currently a shift in career opportunities in mining as it progresses towards mechanisation and automation through robotics. This requires in-depth engineering skills to support and operate mobile mechanised equipment.

MELA team-building.

Department of Mining Engineering final-year class and staff, 2018.

TEACHING AND LEARNING

IMPROVING THE ENGLISH LITERACY OF MINING STUDENTS

The Department of Mining Engineering acknowledges that good language skills are essential for its students to succeed, both in their studies and in their careers. English is not the first language of the majority of the students in the Department. Yet, they need to attend classes, read articles and write reports in English. An inadequate grasp of the English language will therefore lead to poor results, no matter how gifted a student is otherwise.

For this reason, the Department has instituted an English language intervention programme over the past five years, which runs concurrently with the mining engineering classes from the first to the final year of study, providing students with the opportunity to improve their English skills.

Students attend presentations, writing workshops, online programmes and private consultations, which are aimed at helping them improve their writing, reading and speaking skills. This year, the Department appointed three additional postgraduate English tutors to accommodate all the year groups.

The outcome of this intervention is that students have been empowered to produce well-written dissertations and presentations. In the process, they have also acquired a skill that will be of immense value to them throughout their professional lives.

The limits of my language are the limits of my world.
Ludwig Wittenstein

VIRTUAL REALITY PROVIDES AN "EXPLOSIVE" TEACHING EXPERIENCE

The implementation of safe and efficient blasting practices in an underground mining environment contributes to safer working conditions and increased productivity. Training learners in a real production mining environment is often inefficient with associated safety concerns. The University of Pretoria has therefore embraced digital technology to provide training in a "practical" environment through the use of virtual reality (VR).

The establishment of the VR blast training wall in the Department of Mining Engineering enables learners to plan and execute the blasting of a rock face in a controlled and safe environment. By means of VR and augmented reality, they are able to design the blast, mark the blast holes and blast hole timing sequence activities, and actually execute the blast and experience the "explosion" on an interactive screen.

This has the advantage over teaching in a traditional classroom environment, as the learners are able to visualise and fully comprehend the concepts being taught, while gaining practical experience in a user-friendly, safe and erasable environment, where mistakes can be made without any consequences.

The blast wall is projected on a screen, and the learners focus on the marking of grade lines, direction lines and grid lines on the virtual wall, using a computer mouse shaped like a paint brush (again portraying the real-life environment).

It is important for the learners to draw the grade and direction lines accurately, as this will determine the blast hole positions, and ultimately the direction of advance of the tunnel. At this point, they can either proceed to the next step, or delete the lines and start again. The intersection points of the horizontal and vertical grid lines represent the drill hole positions. After marking the drill hole positions, detonator delay numbers are assigned to the blast hole positions.

Once the students are satisfied with the marking and timing of the round, they can watch the simulated blast sequence in real time or slow motion.

The hardware that forms part of this training exercise comprises a personal computer, overhead projector, stereo sound, infrared receivers and an infrared spray can.

The VR blast training wall can also be used to train newly appointed mine workers to effectively master the skills of marking and timing blast rounds in a controlled and "real" environment, and is the perfect tool to give workers refresher training at regular intervals, thereby enhancing their skills and improving the quality of tasks to be performed underground for safe and efficient blast outcomes.

STUDENT ACHIEVEMENTS

Each year, during the annual general meeting of the Mining Alumni Society of UP (MASUP), the Department's top students are recognised. The prizes for excellent performance by students in 2018 were presented by Pieter Coetzee, Manager at Sasol Mining, and Prof Ronny Webber-Youngman, Head of Department. These prizes were awarded as follows:

- MASUP Dissertation Prize for the best dissertation in the final year of study: Johannes Hendrik Maritz
- Sasol Prize for the best academic student in the first year: Andrian Xolani Sibeko
- Sasol Prize for the best academic student in the second year: Lebogang Pitso Mpetle
- Sasol Prize for the best academic student in the third year: Photo Jerry Mokganya
- SACMA Prize for the best final-year student in coal mining: Steven de Jesus
- MASUP and De Villiers Prize for the best students in Geology in the third year of study: Nicolas Quinn Anderson and Ryan Tyler Pedrelli
- Mine Managers' Association of South Africa Prize for the best achievement in the second year of study: Lebogang Pitso Mpetle
- Wolter de Graaf Explosives Engineering Prize for the most dedicated third-year student in Explosives Engineering: Danél Wessels

The recipient of the prizes to be awarded at the April graduation ceremony was also announced. Johannes Hendrik Maritz, who is currently enrolled for an honours degree in mining engineering, will receive the following awards:

- Mine Ventilation Society of South Africa Prize for the best final-year student in Mine Ventilation
- SAIMM Prize for the best final-year Mining Engineering student
- South African National Institute of Rock Engineering Prize for the best student in Rock Mechanics
- MASUP Dissertation Prize for the best dissertation in the final year of study

STUDENT ENGAGEMENT

MESSAGE FROM THE TMS

Thando Nkosi
TMS Chairperson 2019

The Tuks Mining Society (TMS) is a student organisation that exists to benefit UP mining engineering students. It is run by students elected to the executive committee and provides a platform for networking and socialisation among other students and staff of the Department outside of lecture halls. The society's mission is to support the Department's students on a holistic level, and it ensures that students have a voice in the broader university setting.

During the period under review, TMS initiated a mentorship programme where junior students are assigned senior students to assist them with academic issues and provide guidance based on personal experience.

The society also hosted several events, which included the following:

- Departmental Social (Miner's Day)
- Grant Crawley's School of Rock Debate Evening – "contractor mining versus owner mining"

In addition, TMS expressed a desire to become more involved in community development projects. Its main aim was to create an environment where all mining students can interact with various communities with different needs in an attempt to offer assistance and uplift each other. In the process, they succeeded in instilling a spirit of togetherness in the early stages of their careers

The students' first community outreach project was a visit to the Nthutuko Stimulation Centre in Soshanguve on 18 June 2019. The Centre caters for children up to 12 years of age living with various disabilities, including autism, Down syndrome and other neurological disorders.

Their reason for choosing this specific centre was that they were touched by the work performed by these caregivers, who take on the responsibility many shy away from by ensuring that these children grow up in a positive, healthy environment that is conducive to their development.

By visiting the Centre, the members of TMS expressed their appreciation for the efforts of these caregivers and their dedication to their mission.

During their visit, they provided the learners at the Centre with food and detergents. They also spent some time with the learners, and assisted the programme implementers during feeding time. They spent time clearing the Centre's vegetable garden and planting vegetables, which are being grown to supplement their existing diet. The founder of the Centre, Ms Christinah Mahlangu expressed her appreciation of the work done by the team, and their willingness to offer up their time for a worthy cause.

TMS students during their first community outreach.

COMMUNITY ENGAGEMENT

Every year, students in the Department of Mining Engineering participate in the Community-based Project (JCP) module as part of their undergraduate programme. This module, a compulsory module in the Faculty, is a form of experiential learning in which the students use their skills and devote their time to benefit the community.

During the course of the project, the students learn about teamwork, time management and the management of resources. They also become more aware of personal, social and cultural values that will benefit them throughout their careers. They learn to improvise when they encounter challenges and improve their communication skills. These vital skills contribute to their becoming excellent mining engineers who can function effectively in diverse teams and in interdisciplinary environments. The students are encouraged to work with team members from other engineering disciplines.

In 2019, mining engineering student Aobakwe Tshetlho was part of such an interdisciplinary team. Together with computer engineering students Dehan Lamprecht and Maria Makhambeni, and mechanical engineering student Brandon Yelland, the students were involved in a project to teach learners from Tsako Thabo High School in Mamelodi robotics. Upon conclusion of the project, the principal of the school expressed his satisfaction with the skills that the learners had acquired. He had been present at all the instruction sessions and decided to convert a space at the school into a designated robotics lab for future projects. In this way, this initiative can be sustainable and grow into a project that will benefit the community, and enhancing the learners' exposure to science, engineering and technology.

The Mamelodi community benefitted from the involvement of several groups of JCP students, including those from the Department of Mining Engineering, who assisted with various projects at schools in the area as part of what become known as the Mamelodi Initiative.

Students assisting learners in Mamelodi.

A group of JCP students from various engineering disciplines.

STUDENT WELLBEING

In accordance with its value-driven framework, the Department focuses on the wellbeing of its students. The aim is to ensure that it can lend support in order to avert any anxiety that students may experience during their studies. Confidentiality is guaranteed and all cases are handled on merit.

Students are assisted in various ways, including the provision of prescription glasses, daily meals, accommodation and registration fees. The Department also has a loan laptop that it can lend out to students. The financial support of industry is highly appreciated and the funds are put to good use. The Mining Alumni Society of the UP (MASUP) provides support to students in the form of an annual donation. At the annual Presidential Banquet held in 2019, it presented a cheque of R100 000 to the Department to be utilised for students in need. MASUP's newly established Phambili initiative supports students in the Department through bursaries for eligible students, and sponsoring student support structures within the Department. The Southern African Institute of Mining and Metallurgy (SAIMM) supports students in their early years of tertiary education on a year-by-year basis through its SAIMM Scholarship Trust Fund.

DEPARTMENT OF MINING ENGINEERING VALUES

HEARTFELT LEADERSHIP
TRUST AND CARE

- RESPECT
- CARE
- HONESTY
- INTEGRITY
- TRUST

STUDENT EVENTS

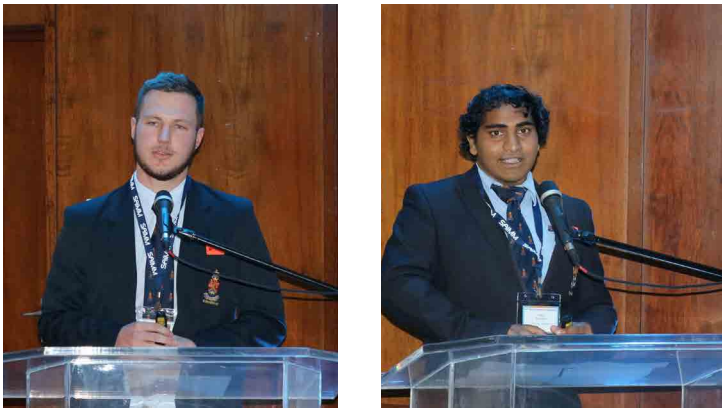
Every year, the Department of Mining Engineering involves itself with Faculty-, campus- and industry-wide events aimed at contributing to the student experience. Three significant events in which UP's Mining Engineering students participated this year were the EBIT Robot Race Day, the SAIMM colloquium and industry mine visits.

Robot Race Day

The Faculty's Department of Electrical, Electronic and Computer Engineering hosts the annual Robot Race Day in which students develop their own robot cars in a quest to master the fundamentals of microcontroller system design. The robot cars participate in an exciting race to determine the winner of the student competition. During this year's event, the Department of Mining Engineering demonstrated the VR capabilities for teaching and learning using Oculus Swift. Participants were taken into an underground mine and exposed to potential dangerous situations that they needed to identify. The collaboration between the departments is important to equip engineering students with the necessary skills to survive and excel towards the Fourth Industrial Revolution.

SAIMM colloquium

Every year, SAIMM presents its student colloquium. The event is intended to give the best students in the fields of mining and metallurgy an opportunity to present their final-year projects. Here, industry experts have the opportunity to meet top young professionals who are about to embark on their careers in industry. The aim of the colloquium is to contribute to the creation of prosperous and empowered young professionals. The Department of Mining Engineering actively participates in this initiative and its students have always performed well. During the 2018 colloquium, two of the Department's final-year students, Henko Maritz and Yugen Govender, were placed in the first and second positions, respectively.



Henko Maritz (left) and Yugen Govender delivering their presentations.

Student mine visits

Each year, the Department arranges for its third-year students to visit mining operations in industry. The mine visits took place between 2 and 12 July 2018.

The third-year student group that participated in mine visits.

PARTICIPATING OPERATIONS

- Klipspruit Colliery
- GoldOne Modder-East operations
- Petra's Diamond Mine
- Sibanye Stillwater's Bathopele Mine
- Mine Rescue Services (MRS)
- Harmony's Joel Operation
- Harmony's Target Mine
- Sibanye Stillwater Beatrix operations
- Association of Mine Managers of South Africa

INDUSTRY COLLABORATION

MINING UNIVERSITIES SOUTH AFRICA

Mining Engineering Education South Africa (MEESA) is a forum established to represent the four universities in South Africa who educate mining engineers. It was inaugurated in 2015 and comprises Mr Lucky Maseko of the University of South Africa, Prof Cuthbert Musingwini of the University of the Witwatersrand (Wits), Prof Ronny Webber-Youngman of UP (the inaugural chairperson) and Prof Hennie Grobler of the University of Johannesburg.

Heads of Department (from left); Mr Lucky Maseko, Prof Cuthbert Musingwini, Prof Ronny Webber-Youngman and Prof Hennie Grobler.

The vision of MEESA is to have a uniform platform for the four mining schools in South Africa to engage and discuss challenges and solutions related to mining education and research, and to foster a spirit of collaboration in this regard so as to benefit the mining industry in South Africa as a whole.

It can boast several achievements to date:

- The four heads of department have benefitted from the opportunity to collaborate to improve collective engagement with the Mining Qualifications Authority (MQA), the Minerals Education Trust Fund (METF) and the Department of Mineral Resources as all four schools are able to discuss common challenges and come up with appropriate solutions.
- As a unified body, the heads of department can speak as one voice when attending to external matters affecting any of the four universities. This is one of the most significant benefits of MEESA.
- The forum provides a sense of purpose for the direction in which mining engineering education and research strategies are developed. Members have learned valuable lessons and have gained important knowledge from the experiences of fellow heads of department to improve their environment and offer quality mining education in South Africa.
- MEESA has presented an opportunity to students from all four universities to work together and share experiences. The forum's unity has given them flexibility and options. It has also improved industry's understanding of how each of the schools of mining engineering operate in order to tap into each other's capacity, including research capacity and the co-supervision of postgraduate students. It also provides the opportunity to discuss common student and staff interests, including the sharing of lecture loads and the development of module content. Finally, it provides a common research focus and network for collaboration in areas of mutual interest.

Since its inception, there has generally been a very positive experience among the four heads of department currently making up the membership of MEESA. There is also very positive feedback from all industry role players. The proposed collaboration on projects of the Mandela Mining Precinct shows the influence of the forum.

Future plans include formalising research exchange programmes in the context of internationalisation, with a specific emphasis on research and co-publication with international partners. It is believed that MEESA will go from strength to strength.

INDUSTRY FUNDING

In the year under review, as in the past, the Minerals Education Trust Fund (METF) once again honoured its staff salary subvention commitment. Without this, it would have been very difficult to attract and retain quality lecturing staff for the Department. Capital and discretionary funds received from the METF are being allocated to acquire assets for immersive teaching, as well as laboratory equipment to further facilitate the learning experience, specifically for rock engineering, mine ventilation and virtual reality. It also once again made the appointment of a staff member for English Literacy possible.

The Department of Mining Engineering is committed to contributing to the mining industry at large through research, teaching and learning. It collaborates with both the local and global academic mining engineering community.

REPRESENTING THE GLOBAL ACADEMIC COMMUNITY THROUGH SOMP

Delegates of the meeting of the international Society of Mining Professors (SOMP) at Tian An Men Square, Beijing, in July 2018.

The Department of Mining Engineering at the University of Pretoria is a member of the global academic community. Prof Ronny Webber-Youngman serves as an African representative on 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.

The main goal of this society is to guarantee the scientific, technical, academic and professional knowledge that is required to ensure a sustainable supply of minerals for mankind. It facilitates information exchange, research and teaching partnerships, as well as other collaborative activities among its members.

The 2018 annual general meeting (AGM) (the society's 29th AGM) was held in Beijing, China, from 3 to 6 July 2018. Prof Webber-Youngman, Head of the Department, was proud to represent UP's Department of Mining Engineering at this event.

INDUSTRY-FOCUSED ACTIVITIES AND EVENTS

The Department receives various visits from members of industry each year as part of its commitment to collaboration. It also hosts events that facilitate networking and cooperation between members of industry. Some highlights from the period under review include the following:

A visit by Sabine Dall'Omo, the CEO of Siemens South Africa, and her team – pictured along with Prof Sunil Maharaj (Dean of EBIT) and Prof Ronny Webber-Youngman (HOD of the Department).

The Department's Annual Golf Day, held on 7 December 2018, was supported by Dr Bertie Meyer, President of the Mining Alumni Society of UP (MASUP), and his team.

The President of the Association of Mine Managers South Africa (AMMSA), Willie Theron (a UP alumnus), and his Council members visited the Department.

The President of the South African Colliery Managers' Association (SACMA), Oos van der Merwe (a UP alumnus), and his Council members visited the Department.

SUPPORTING INDUSTRY WITH SHORT COURSES

Short courses not only contribute to the Department's third-stream income activities, but also elevate its visibility in the mining industry. They make the expertise of the Department available to members of industry for purposes of skills development and capacity building. They also enable individuals in the mining sector to become more effective in the development of smart, long-lasting solutions for society.

During the period under review, the Department continued to present short courses in risk management for the mining industry based on the Safety Risk Management Programme (SRMP) that was established by Anglo American in 2008 and has been further developed and enhanced over the last decade.

The period also marked the Department's 12th year of active involvement in risk management for the mining industry.

Lecturers who were actively involved in presenting the course include Mr Albert van der Vyver, Prof Krige Visser, Mr Gordon Olivier, Mr Hannes Koekemoer, Mr Paul Maré and Mr Mike Gouws. It is envisaged that this will continue in 2018/19.

The Department also continued its delivery of a short course in mining for non-mining professionals. The Kumba Virtual Reality Centre for Mine Design was included as part of the offering. This was well received by all delegates.

The Blasting Engineering Programme, presented by Mr Wolter de Graaf, is in its sixth year of operation. To date, 224 delegates have successfully completed the programme. The programme was also presented in Mali during the latter half of 2018.

The Open Pit Planning and Design short course was presented in conjunction with VBKOM Consulting Engineers. This is a five-day course facilitated by Mr George Olivier.

Two new courses were developed for presentation in 2019. These are a course in dewatering, to be presented by Dr Kym Morton, and a course in surface mining excellence, to be presented jointly by Mr Johann Hager and Mr Henk Fourie.

A major value addition in terms of the involvement of the mining industry in the short courses presented by the Department was the establishment of the Leadership Capacity-building short course for Harmony Gold under the guidance of Prof Ronny Webber-Youngman and Dr Johann Uys. From its inception until 30 June 2019, 357 members of Harmony Gold participated in this course (39 executives, 95 senior staff members and 223 junior staff members).

Other courses that form part of the Department's funding strategy include a Rock Engineering short course, presented by Mr Jannie Maritz.

The full list of professional development courses is available at www.up.ac.za/en/mining-engineering/article/48890/short-courses.

Graduates of the Leadership and Capacity-building course from Harmony Gold.

ALUMNI

DEPARTMENT RECOGNISES SUPPORT OF MASUP

The Department of Mining Engineering enjoys the active support of its alumni through the Mining Alumni Society of the University of Pretoria (MASUP). Members of the society support the Department by raising sponsorships, ensuring that a high level of skills and educational standards are maintained, offering mentorship, providing external examiners, being available for industry discussions, offering guidance and serving on the Department's Advisory Committee. It also serves as a social network for mining engineers in industry.

At its annual general meeting (AGM) held on 24 May 2019, MASUP awarded its Gold Medal Achievement Award, as well as its annual student prizes to the top-performing students for 2018 at undergraduate level. The event was opened with a welcoming address by the Dean of the Faculty of Engineering, Built Environment and Information Technology, Prof Sunil Maharaj. This was followed by the keynote address, delivered by Mike Teke, CEO of Seriti Resources and former president of the Minerals Council South Africa (formerly the Chamber of Mines).

The highlight of the event was, of course, the presentation of the Gold Medal Achievement Award of 2019 to Prof Alf Brown, Head of the Department of Mining Engineering of the University of Pretoria for 16 years from 1981 to 1996. This award honours and recognises the achievements and contribution made by an alumnus to the Department of Mining Engineering and the mining industry as a whole, and was presented by Prof Con Fauconnier, Honorary President of MASUP.

The prizes for excellent performance by students in 2018 were presented by Pieter Coetzee, Manager at Sasol Mining, and Prof Ronny Webber-Youngman, Head of Department.

PRESIDENTIAL DINNER

MASUP also hosts its Presidential Dinner each year. In 2018, the prestigious event took place on 3 November. During the Presidential Dinner, MASUP presented the Department with a donation of R100 000. This generous donation was used to support 25 second-year students with their training at AngloGold Ashanti's Mponeng mine.

Prof Ronny Webber-Youngman receives the MASUP's donation.

MASUP COMMITTEE

The new MASUP Committee for 2019/20 was elected at the AGM:

President: Dr Bertie Meyer
Vice President: Takalani Randima
Treasurer: Quentin Botha
Members:
Head of Department: Prof Ronny Webber-Youngman (ex officio)
Bennie Burger
Gerrie Brink
Danie Lourens (Past President)
Ben Bruwer (Past President)
Francois Nell
Riaan Gilfillan
Thando Nkosi (Student Representative)

Prof Con Fauconnier also agreed to serve for another three-year term as Honorary President of MASUP.

Keynote address: Mike Teke, CEO of Seriti Resources.

Prof Con Fauconnier (left) and Prof Alf Brown.

Prof Ronny Webber-Youngman (far right) with the recipients of the student awards.

Newly elected President of MASUP, Dr Bertie Meyer.

ALUMNI GIVE BACK TO THE INDUSTRY THROUGH THE PHAMBILI INITIATIVE

MASUP recognises that increasing local and global demands have been made on the industry over the last decade. It believes that the choices made by stakeholders in the short term will shape the future of the industry. It therefore launched an empowerment initiative that will enable the industry to secure its own future state through a shared vision.

This initiative, known as Phambili, is a call to action. It is based on the philosophy of ubuntu: the belief in a universal bond of sharing that connects all humanity. The rationale behind Phambili is that it will provide stakeholders with solutions that will secure sustainability for the industry at large, striking a balance between improving transformation and ensuring the industry's viability in a volatile environment.

Through this initiative, alumni of the Department endeavour to create real impact in alignment with the country's National Development Plan (NDP) by creating pathways that define transformation and reshape the form, nature and perception of the mining industry. It intends to create a platform that not only influences industry, but promotes interaction between members and industry, with the aim of achieving tangible return on investment through combined efforts to achieve sustainable transformation.

Through collaboration with industry stakeholders, MASUP hopes to contribute to seven of the elements in the NDP by redirecting its efforts and spend to promote gender equality, maintain quality education and commit to partnerships that will achieve economic growth and industry innovation.

Phambili is a two-pronged initiative, comprising two programmes: Phambili Merits and Phambili Innovation.

Phambili Merits focuses on skills development by providing the following:

- Bursaries to support eligible students within the Department of Mining Engineering
- Sponsoring student support structures within the Department
- Customised skills programmes to support career development
- Re-skilling employees within the mining sector to enable them to remain relevant to market changes

Phambili Innovation focuses on providing a service that will align business transformation efforts with industry needs by deploying innovative solutions to traditional business challenges. This initiative is delivered through the following:

- Industry-focused research and development projects
- Partnering within the MASUP stakeholder network to create industry-specific enterprise and supplier development programmes
- Investing in socio-economic development that supports industry outcomes

Stakeholders wishing to support this initiative can contact Bennie Burger at masup.committee@gmail.com

PROMINENT ALUMNI

The Department boasts with several alumni who have reached the highest ranks of business, not just in the mining industry. The names of prominent alumni are regularly brought to the attention of the Department, but that does not mean that the following alumni (listed alphabetically) are the only industry leaders who have gained recognition on the basis of a degree obtained from this Department. We therefore acknowledge those alumni whose achievements have not been brought to our attention as well.

- Mr Rassie Alberts, COO
- Mr Theo Bothoulas, CEO
- Mr Johan de Vos, MD
- Prof Con Fauconnier, CEO
- Mr Hennie Faul, CEO
- Mr Dirk Fourie, COO
- Mr Louis Germishuys, COO
- Mr Chris Griffith, CEO
- Mr Rikus Grimbeek, COO
- Mr Johan Jansen, CEO
- Mr Koos Jordaan, CEO
- Mr Pierre Jordaan, Head of Mining
- Mr Rowan Karstel, CEO
- Mr Manie Kriel, CEO
- Mr Dirk Kruger, MD
- Mr Henry Laas, CEO
- Dr Gys Landman, CEO
- Mr Jaqco Lottering, MD
- Mr Floyd Masemula, Senior Vice-President
- Mr Nico Muller, CEO
- Mr Byers Nel, COO
- Mr Gerhard Potgieter, COO
- Mr Peter Steenkamp, CEO
- Mr Bernard Swanepoel, CEO
- Mr Hugo Tukker, MD
- Mr Don Turvey, CEO
- Mr Francois Uys, CEO
- Mr Wilco Uys, CEO
- Mr Riaan van der Merwe, COO
- Mr Riaan Vermeulen, Head of Mining

The delicate balance of mentoring someone is not creating them in your own image, but giving them the opportunity to create themselves.

Steven Spielberg

ALUMNI PARTICIPATION

SANIRE

Jannie Maritz, a senior lecturer in the Department, was elected as the President of the South African Institute of Rock Engineering (SANIRE) for the term 1 July 2017 to 31 June 2019. He had served as Vice-President from 2015 to 2017.

ADVISORY BOARD

The Department benefits from the expertise of the following leaders from industry and academia who serve on the Mining Engineering Advisory Board:

- Prof Sunil Maharaj, Dean: Faculty of Engineering, Built Environment and Information Technology
- Prof Josua Meyer, Chairperson, School of Engineering
- Prof Ronny Webber-Youngman, Head of Department of Mining Engineering
- Dr Bertie Meyer, President of MASUP

- Mr Riaan van der Merwe
- Mr Wilco Uys
- Prof Con Fauconnier
- Mr Bernard Swanepoel
- Mr Don Turvey
- Dr Gys Landman
- Mr Francois Uys
- Mr Gerhard Potgieter
- Mr Chris Griffith
- Mr Pierre Jordaan
- Mr Joshua Ngoma
- Mr Peter Steenkamp
- Mr Johan de Vos
- Mr Rowan Karstel
- Dr Gordon Smith
- Mr Rassie Alberts
- Mr Corné Strydom
- Mr Dick Kruger
- Dr Nombasa Tsengwa
- Mr Mike Teke

Members of the Mining Engineering Advisory Board.

PARTNERS

INDUSTRY PARTNERS

AEL Intelligent Blasting

African Rainbow Minerals (ARM)

AfriSam

Anglo American

Assmang (Pty) Ltd

Caledonia Mining Corporation

CCS Mining & Industrial

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Excavo Mining (Pty) Ltd

Gigajoule Group

Glencore

Harmony Gold

I-CAT Environmental Solutions

INSA Coal Holdings

Krypton Mining

Kumba Iron Ore: Anglo American

Mapondo Tanks (Pty) Ltd

Maptek

Minerals Council South Africa

Minerals Education Trust Fund

Minxcon Mining and Exploration Consultants

Msobo Coal

Murray & Roberts

New Mining Conceptrs

Newark Mining

Petra Diamonds

Rainbow Reservoirs

REC Services (Pty) Ltd

Redpath Mining Contractors and Engineers

RPMGlobal

Sasol

South 32

Stefanutti Stocks

Ukwazi

VBKOM

UNIVERSITIES

Clausthal University of Technology

University of Exeter, Camborne School of Mines

GOVERNMENT INSTITUTIONS

Department of Mineral Resources

Mine Health and Safety Council

Mining Qualifications Authority

PROFESSIONAL ASSOCIATIONS

Association of Mine Managers South Africa

Engineering Council of South Africa

South African Colliery Managers' Association

Southern African Institute of Mining and Metallurgy

South African National Institute of Rock Mining

The Mine Ventilation Society of South Africa

SCIENCE COUNCILS

Council for Geoscience

Council for Scientific and Industrial Research

CSIR Mining Precinct

MINTEK

Department website

http://www.up.ac.za/mining-engineering

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