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UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

**Faculty of Engineering,
Built Environment and
Information Technology**

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

Make today matter

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AN ENGINEERING PERSPECTIVE ON THE LEADERSHIP PROBLEM

Hendrik van der Bijl Memorial Lecture: The experience of Greg Solomon, CEO of McDonald's South Africa, on the topic "We have a leadership problem".

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NEW VIRTUAL CONFERENCE CENTRE IN THE MINERAL SCIENCES BUILDING

This latest development in the Department of Materials Science and Metallurgical engineering, sponsored by African Rainbow Minerals (ARM), is set to enhance collaboration between academia and industry.

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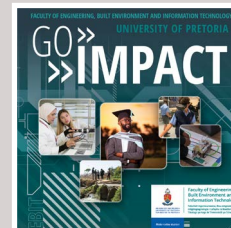


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GROWING INDUSTRY CONNECTIONS IN TIMBER DESIGN AND CONSTRUCTION



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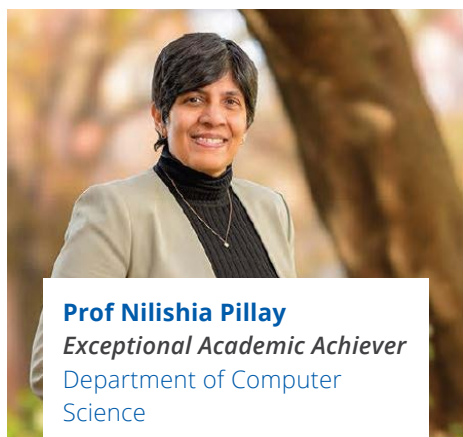


UP ACADEMIC ACHIEVERS' AWARDS: PUSHING THE UNIVERSITY TO NEW HEIGHTS

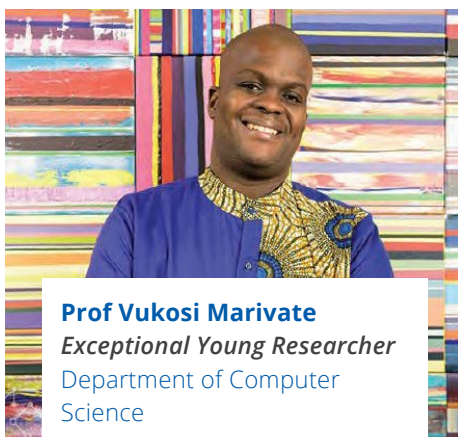
The University of Pretoria's 24th annual Academic Achievers' Awards acknowledges the work of UP staff members whose research centres on addressing society's most pressing problems and has a positive impact, both locally and globally. UP Vice-Chancellor and Principal, Prof Francis Petersen, congratulates the researchers who received awards.

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NATIONAL RESEARCH
FOUNDATION (NRF)-
RATED RESEARCHERS
IN EBIT



Prof Nilishia Pillay
Exceptional Academic Achiever
Department of Computer
Science



Prof Vukosi Marivate
Exceptional Young Researcher
Department of Computer
Science



Dr Calayde Davey
Exceptional Young Researcher
Department of Architecture

Prof Nelishia Pillay is a full professor in the Department of Computer Science. She holds the DST/NRF co-funded SARCHI Chair in Artificial Intelligence for Sustainable Development and the MultiChoice Joint Chair in Machine Learning. She is currently Chair of the Institute of Electrical and Electronic Engineers (IEEE) Computational Intelligence Society (CIS) Subcommittee on Diversity, Equity and Inclusion, the IEEE CIS Mentoring Subcommittee and the IEEE CIS Outstanding Dissertation Subcommittee. She serves as an elected member of IEEE CIS Adcom. Her area of research involves improving current and developing new artificial intelligence algorithms to solve complex real-world problems related to the United Nations' Sustainable Development Goals, with a focus on innovation in industry, health and wellbeing, renewable energy and lifelong learning.

Prof Vukosi Marivate holds the Absa UP Chair of Data Science and is an associate professor in the Department of Computer Science. His research focus is artificial intelligence (AI) and natural language processing (NLP), focusing on local and low-resourced languages. He leads the Data Science for Social Impact (DSFSI) research group, which explores data science methodologies to address societal challenges, especially in Africa. He co-founded Lelapa AI, a socially grounded, Africa-centric AI startup, and Masakhane NLP, an open and collaborative research initiative focused on improving NLP for African languages. He is also one of the founding members of the Deep Learning Indaba, an initiative dedicated to strengthening machine learning and AI research across Africa by fostering collaboration, on the continent. Beyond his academic work, he is highly engaged in community-driven science initiatives.

Dr Calayde Davey is a senior lecturer in the Department of Architecture. She is dedicated to exploring the transformative potential of urbanism, transdisciplinary professional practice and innovation within the African built environment. She leads the Urban Strategy Studio and the Hatfield Digital Twin City (HDTC) Initiative at the University of Pretoria, which integrates academic learning with professional practice in transdisciplinary settings. She is a board member of BIMCommunityAFRICA, where she established and has run the annual BIMHarambee industry-academia conference since 2022. She received the University of Pretoria Institutional Teaching and Learning Award in 2023 and the 2023 Quanser Global Sustainability Award for Engineering Education. Her work seeks to impact the African built environment through her innovative approach to education and practical applications in architecture, design and urban strategy.

[Download](#) the full publication to learn more about the winners, their research and their special projects.

Encouraging individual participation in a groupwork project

Dr Werner Badenhorst, a senior lecturer in the Department of Electrical, Electronic and Computer Engineering, received the Faculty's Teaching and Learning Award for 2024 in recognition of the success he had achieved in overcoming the challenge of evaluating individual participation in a groupwork project.

The motivation for this innovative approach found its origin in 2020 when the constraints and challenges presented by the COVID-19 pandemic led to the combination of three individual third-year Engineering Design modules for electrical, electronic and computer engineering into a single module. In this combined Design module, students worked in groups of three to develop a line that could be incorporated into the microcontroller-based automated robotic vehicle (MARV) that is developed and built in the first-semester Microprocessors module to take part in the annual Robot Race Day.

In 2021, the line to be incorporated into the MARV was again developed and constructed in the first semester as part of the third-year Microprocessors module for the annual Robot Race Day. This left the second-semester Design module without a project to design. Dr Badenhorst therefore decided to use the same structure and plan developed in 2020 and convert the line following the MARV developed in the first-semester Microprocessors module into a maze-navigating MARV. This was named the "A-Maze-Eng MARV".

The Design module has double the practical time of a typical 16-credit module to provide sufficient time for the project's physical implementation. This emphasises the importance of the practical component of the module as the laboratory demonstrations account for 45% of the semester mark. Dr Badenhorst is responsible for the practical elements, while other lecturers present the theoretical content, applying systems engineering concepts to develop the MARV. It is essentially one project with four different phases taught in class and evaluated in four separate demonstration phases.

The Design class typically has between 180 and 200 students, divided into groups of three students from the Department's three disciplines. Each group designs and builds an A-Maze-Eng MARV that can navigate through a maze. The electrical engineering application involves the design of the motor drive and power subsystem. The electronic engineering perspective focuses on the design of the sensor subsystem, while the computer engineering work entails the design of the state and navigation control subsystem. The three subsystems must be integrated physically, as well as through a given serial communication protocol.

Dr Badenhorst developed a set of quality test procedures to evaluate each subsystem's adherence to the system and subsystem's requirements and specifications. This was done using the HUB graphical user interface. This is a Pygame (Python) emulation of the



integrated system with which students and evaluators can test the individual subsystem's quality test procedures as if the subsystem under evaluation were physically integrated with the other two subsystems.

Where possible, the module enforces multidisciplinary groups. Once the group has been formed, the members must decide who will design and implement the individual subsystems. The module's assessment plan requires four evaluation teams, each comprising three evaluators: one for each of the three subsystems. The project is evaluated over four demonstration phases, with specific milestones evaluated in each phase.

The Design module's focus on design and implementation enables it to form an integral part of the Department's vertically integrated curriculum, as it encompasses all three of the Department's degree programmes (electrical, electronic and computer engineering). Its inclusion of contributions from several second- and third-year modules turns it into a critical space to prepare students to transition to their final-year capstone project.

INAUGURAL LECTURES FROM UP EXPERTS



MINDING AND MENDING OUR WAYS

Prof Wynand JvdM Steyn
Dean of the Faculty of
Engineering, Built Environment
and Information Technology

Roads are essential infrastructure that weave through the fabric of our societies. They are the conduits that connect communities, enabling access to education, healthcare, trade and safety. Beyond this functionality, roads also serve as the threads that bind us and shape our collective journey. Vehicle-pavement interaction lies at the heart of road engineering. It is the intricate dance between vehicle tyres and roads, where physics, materials science and engineering converge. Here, science meets practicality, ensuring that roads endure, vehicles ride smoothly, and our lives move forward. Prof Steyn's lecture took delegates through his 35 years of research on the interrelationships between roads, road users and the ways in which roads affect journeys and users adapt to roads. He reflected on how he has observed and quantified these interactions (minding) and how he has contributed to the construction, maintenance and rehabilitation of roads (mending) to ease the burdens of accessibility and mobility in support of communities. His research journey spans from rudimentary to high-tech data collection and analysis, along with reflections on the meaning of such data and the opportunities to maintain and rehabilitate infrastructure. He also shared his insights into the importance and implications of this research for both users and infrastructure. Looking ahead, he emphasised the need for foresight in vehicle-pavement interaction to ensure sustainable and healthy transportation practices through continuous and automated monitoring and maintenance. He concluded that any successful journey depends on mutual respect between the user and the road, which prevents overstressing and helps maintain smooth road surfaces.



THE FUTURE OF THE MANUFACTURING PLANNING AND CONTROL SYSTEM AND THE SENSOR OF THE INTANGIBLES

Prof Olufemi Adetunji
Head of the Department of
Industrial and Systems Engineering

Manufacturing Planning and Control (MPC) is the heart of production systems. It reconciles customer demand with the requirements for production resources (inventory and capacity) and guides the necessary trade-off decisions, guided by an appropriate production management philosophy. In his presentation, Prof Adetunji traced the evolution of industrial engineering, starting from basic productivity engineering after the first industrial revolution. He also mentioned some of its prominent subdisciplines today, including MPC. Subsequently, he discussed industrial engineering's role in the competitiveness of nations and the concept of a work system as the operating environment of industrial engineering. He then presented inventory management within the MPC framework, and reviewed models for deteriorating, ameliorating, growing and recoverable inventory items as his main research field. Furthermore, he highlighted some applications of these inventory areas, like food chains and circular manufacturing. He then presented softer issues of production management philosophies and his research in understanding how these affect the efficiency of work systems. He also looked into the future of MPC and anticipated how it will evolve based on Artificial Intelligence and the Industrial Internet of Things (IIoT). He presented the Manufacturing Execution System (MES) layer of the IIoT's five-layer architecture as the digital realisation of the MPC, and discussed his future research direction. Finally, he presented the idea of the sensor of the intangibles (Sol), how it may influence the design of an intelligent MES (IMES) layer of the future IIoT, and how Sol may integrate economic and human factors in the future IMES architecture.

INAUGURAL LECTURES FROM UP EXPERTS



CROSSING BOUNDARIES AND CRAFTING FUTURES: THE ROLE OF INDUSTRY PARTNERSHIPS IN TRANSDISCIPLINARY RESEARCH

Prof Hanlie Smuts
Head of the Department of Informatics

Transdisciplinary research and knowledge translation are crucial for addressing complex global challenges, such as urban development, smart cities, digital transformation, healthcare digitalisation, and supply chain management. This approach integrates scientific and non-scientific methods and involves diverse stakeholders to produce both publishable research and practical solutions with societal impact. However, challenges include poor communication across disciplines, competing interests, time allocation, impact measurement, and balancing divergent and convergent thinking. In her address, Prof Smuts emphasised the ABC principle (Applied and Basic Combined), and highlighted the essential role of industry partners in transdisciplinary research. Drawing from her experience in managing commercial relationships and overseeing joint research projects, she illustrated how integrating diverse knowledge and expertise addresses complex challenges. Industry partnerships offer vital resources, expertise and real-world data, enhancing research relevance and impact. Close collaboration between academia and industry co-creates solutions, addressing societal needs, accelerating innovation, facilitating knowledge transfer and promoting scalable solutions. She shared her framework and approach to empower researchers and industry partners to scale their engagement in transdisciplinary projects. Fostering equitable collaborations can harness transdisciplinary research's full potential, creating a more sustainable and inclusive future. This address underscored the importance of strong academia-industry partnerships, driving interdisciplinary innovation for societal benefit. Academia can expand its academic horizons, translate knowledge into real-world solutions, and enrich teaching and learning.



BEING HUMAN IN THE AGE OF AI: RETHINKING 21ST-CENTURY SKILLS

Prof Machdel Mattee
Department of Informatics

As early as 1982, Gordon Pask, a well-known cybernetician, argued that “revolution from the industrial environment to an information environment consists not of technological change or changes in employment patterns, but of changes in the mental framework that makes our environment coherent to us”. Twenty-first-century skills have been suggested as a set of skills contributing to the mental framework to prepare humans for the digital age. Critical thinking, creativity, communication and collaboration (the 4Cs) are generally accepted as the core of this skill set. The digital transformation agenda of recent decades, coupled with the advent of disruptive generative AI, has intensified the need for skills that can make sense of our computed reality. Since the introduction of disruptive technologies such as big data, AI, augmented reality, robotics, blockchain and cloud computing, a new set of skills has been required for people to live and work in the 21st century. Scholars concur that humans must assume their place as partners in this human-machine world, not merely as consumers, but as active agents in envisioning and creating new and alternative digital realities. In her address, she provided highlights of her involvement with developing 21st-century thinking skills in various audiences over the past decade. Informed by this experience, she argued for the need to re-evaluate and reconceptualise 21st-century skills in the age of AI. Drawing on insights from philosophers of technology, educationalists and modern pedagogies, with human dignity and human agency as guiding principles, she explored and illustrated the expansion and enhancement of these inherently human skills to enable meaningful co-existence and co-creation with current and future digital technologies. She concluded that education can be seen as taking care of the environment, ourselves and our technological creations. The learning context of the future will include the digital context, together with human-machine collaboration. Innovative pedagogies and alternative assessment methods are therefore crucial.

An engineering perspective on the leadership problem



The experience of McDonald's South Africa's CEO

Members of the South African Academy of Engineering were enthusiastic to hear the perspective of Greg Solomon, CEO of McDonald's South Africa, on the topic "We have a leadership problem" at the annual Hendrik van der Bijl Memorial Lecture, held at the University of Pretoria on 10 October 2024.

This lecture is an annual event hosted by the South African Academy of Engineering, in collaboration with the University's Faculty of Engineering, Built Environment and Information Technology. It commemorates the contributions of Van der Bijl, a giant in industry, to the industrial and scientific development of South Africa. It has been held since 1963 and has featured many eminent persons whose work illustrates the general theme of the role of engineering in society.

Solomon is a successful business leader and humanitarian, who puts people first, and believes in making a difference in terms of inclusivity, equity and diversity. Having trained as a civil engineer, he is the epitome of an engineer who has migrated to another industry where he has made an impact with the skills he has acquired. Explaining the topic of his presentation, he reflects, "as engineers, we are leaders, and have to make sure that we contribute a solution to the leadership problem in South Africa".

He described the three aspects that are essential to leadership and management: leading yourself, leading others and leading business. "It is all about doing things differently."

He identifies the two prerequisites of a true leader to be trust and respect. "It is all about delivering on your promises." His experience with McDonald's South Africa serves as an example of how to manage a business by managing its people and its systems.

He explains that when the external environment changes faster than the internal environment, it is easy to become irrelevant. His advice is that one should continue to evolve and change, and most importantly, learn. "One needs to focus on scalability and sustainability by paying attention to where transformation needs to take place."

Solomon places great emphasis on the choices one makes: both in business and in one's personal life. "In South African business, and particularly in the retail industry, we are standing at a crossroads, where we need to find solutions to two important challenges: youth unemployment and purchasing power." He believes that one's decisions have the power to transform business, to transform the youth, and to transform the country.

Choosing wisely, thinking carefully and making well-calculated choices are the secrets to his business success. "To run a responsible business, you need to think ahead so that you can respond to any unexpected challenge,"

he says. He believes in nurturing a culture of innovation, and the importance of continuing the education journey.

He contemplated other important elements of a successful business. These include having contingency plans in place, being a nimble business leader with an analytical mindset and playing out different scenarios for any future situation. "When something changes by the power of 10, something needs to change fundamentally," he explains.

"I believe our power lies in our differences, and that it is our values that bring us together." He therefore subscribes to the values of service, inclusion, integrity, community and family, where he puts his staff and his customers first. He also believes that it is the smallest things that make the biggest difference. For that reason, he ensures that the focus of every single store in the chain is characterised by quality, service, cleanliness and value.

He also believes in the importance of balancing relationships, and holding people accountable, which is why the tripartite relationship between the franchisees, the corporation and the company's suppliers form a key part of the brand's strategic plan, with the customer and staff members as the ultimate beneficiaries.

Generating electricity and heat with a mobile solar-dish gas turbine hybrid

Prof Willem le Roux



South Africa receives an average of over 2 500 hours of sunlight a year, placing it among the countries with the most potential for solar electricity and heat generation in the world. Several innovative means of power generation have been developed that tap into the sun's abundant energy using concentrated solar power systems. These systems redirect the sun's rays towards a focal point to enable thermal energy capture.

A research team in the **Department of Mechanical and Aeronautical Engineering** has developed a mobile solar-dish gas turbine hybrid using a micro gas turbine for smallscale power and heat generation. The effectiveness of this method of power and heat generation relates to the turbine's high inlet temperature and low emissions. Mobile energy systems can provide access to electricity and heat where grid access is limited, especially in rural areas. A prototype is therefore being developed for testing and in an operational environment. Once it has been rolled out, it can be transported to rural areas when the need for electricity and heat arises.

Micro turbines are versatile, as they can operate on various fuels, from diesel to natural gas or liquid petroleum gas (LPG). They can have a low noise output and are relatively vibration-free. The turbine and compressor are usually attached to a single shaft through a single-stage, radial flow application. Micro turbines can also utilise solar thermal energy in a hybrid configuration and its high-temperature exhaust can be used for co-generation. A solar dish can supplement or replace the heat added by the fuel to further reduce the micro turbine's emissions.

The hybrid gas turbine configuration that was developed has the advantage of being able to generate electricity and heat using concentrated solar energy and LPG as energy sources. Electricity is generated from the output shaft of the micro turbine, while high-temperature exhaust gases are used for metal melting (or recycling) and water heating purposes.

Small-scale co-generation concentrated solar power (CSP) plants can be compact, and can improve accessibility to heat and power in off-grid rural environments. A hybrid solar-dish Brayton cycle combines heat and power generation, where heat is sourced from combustion, as well as through the focal point (the cavity receiver)

Collaboration for IMPACT

The University of Pretoria's Department of Materials Science and Metallurgical Engineering is unique in South Africa as it is the only department entirely dedicated to metallurgical engineering. It provides aspiring metallurgical engineers with a comprehensive education in minerals and metals, covering a wide range of topics.

It has been ranked as the **best metallurgical engineering department at a South African university** for several consecutive years by the Minerals Education Trust Fund (METF). It was also ranked **36th in the world for minerals and mining engineering** in the latest QS rankings. This acknowledges the Department's valuable impact on the field, both in terms of knowledge advancement and producing skilled professionals. Its commitment to providing advanced education and state-of-the-art facilities ensures that its graduates are well prepared to meet the challenges of the modern world. The University of Pretoria has become a centre for metallurgical research, focusing on issues relevant to South Africa's mining industry, including mineral processing, metal extraction and alloy development.

In this regard, the Department understands the importance of maintaining close working relationships with local industry. Students in metallurgical engineering are often awarded bursaries by local companies, which can lead to employment after graduation. In addition, collaboration with industry partners enhances the relevance of its research programme, which enables the Department to serve as a technical resource for industry, providing information and expertise. This can only be achieved with a robust team of academic staff members.

The Department produces outstanding alumni who hold executive positions in industry. These alumni play a vital role in driving changes and maintaining the high quality of graduates over the years. The Department maintains close relationships with its alumni through, for example, its Advisory Board. This board helps align the Department with industry changes and trends, and supports the implementation of desired improvements within the Department.

The latest development in the Department, which included the establishment of a high-tech Virtual Conference Centre to enhance online collaboration sponsored by African Rainbow Minerals (ARM), was the large-scale refurbishment of the Department's facilities in the Mineral Sciences Building.



Phillip Tobias, Chief Executive Officer of African Rainbow Minerals (ARM) (left) and Prof Sunil Maharaj, UP's Vice-Principal for Research, Innovation and Postgraduate Education, officially open the UP-ARM Virtual Conference Centre.

The new ARM Virtual Conference Centre, which was officially launched on 18 October 2024, is a state-of-the-art facility aimed at enhancing collaboration between academia and industry. It will empower staff and students to connect and engage virtually with local and international institutions of higher learning, academic communities, research organisations and industry leaders.

By fostering collaboration, the virtual centre will enrich students' educational experiences and facilitate the rapid exchange of information and data, ensuring the timely delivery of high-quality results. It serves as a collaborative space for various departments within the faculties of Engineering, Built Environment and Information Technology, and Natural and Agricultural Sciences, enabling high-tech meetings, workshops and seminars that enhance engagement among staff, students and industry partners.

Key departments, including Geology, Mining Engineering, Materials Science and Metallurgical Engineering, and Mechanical Engineering, which together host over 150 postgraduate students, will greatly benefit from this facility.

By providing access to cutting-edge technology, the UP-ARM Virtual Conference Centre aims to modernise academic research and industry applications, enabling more effective collaboration between students, staff members and industry leaders.

This centre will be instrumental in bridging the digital divide in our universities, nurturing the next generation of leaders and thinkers equipped to thrive in the digital age.

Converting water hyacinth carbon biomass to green energy: Global collaboration leads to a sustainable solution

Water, as a precious natural resource, is indispensable for safeguarding human health and ensuring agricultural food production. However, the convergence of climate change, escalating water pollution, unequal resource distribution and the constrained availability of clean water resources has led to over a billion people worldwide having limited access to safe drinking water. To exacerbate the issue, the proliferation of invasive species, often associated with eutrophication, has resulted in a deterioration in the water quality of existing water bodies intended for human consumption.

An invasive species that is particularly problematic in the regard is the water hyacinth (*Eichhornia crassipes*). This pervasive aquatic plant has become a formidable challenge in areas of southern Africa and parts of Central and North America. Once this plant takes root in a water body, its eradication becomes an arduous task. Studies in lakes and rivers worldwide have revealed its profound impact on water quality and the loss of biodiversity, while the stagnant water areas under its dense mats create an ideal habitat for disease-carrying vectors such as mosquitoes.

In an attempt to address the global challenges associated with climate change and public health, the World Universities Network Research Development Fund allocated an award to Prof Evans Chirwa, Head of the Water Utilisation Division in the Department of Chemical Engineering and Chairholder of the Rand Water Chair in Water Utilisation at the University of Pretoria. He is the Principal Investigator and Academic Lead in a collaborative, transdisciplinary research project in this area



Prof Evans Chirwa

of water utilisation that affects not only Africa and the Global South, but areas of North America, Central America and South East Asia as well.

The project is being conducted in collaboration with a multi-disciplinary team of 14 researchers from the University of Pretoria (South Africa), the Technological Institute of Monterrey (Mexico), the University of Leeds (United Kingdom), Makerere University (Uganda) and the University of Technology Sydney (Australia).

The team comprises chemical and electronic engineers, biologists, microbiologists and geneticists. The engineers' role was to develop controls in targeting water hyacinth, while minimising harm to non-target species, and to create efficient, cost-effective, and environmentally safe control and monitoring methods. The biologists studied the water hyacinth's life cycle, growth patterns and reproductive behaviour, and identified possible biological controls. They also monitored and mapped invasive species and their impact on the native fauna and flora. The microbiologists' role was to investigate microbial communities associated with water hyacinth, and to explore potential growth inhibition. They also explored microbial-based solutions by introducing beneficial microbes for growth suspension. The geneticists analysed the plant's genetic diversity and factors that contribute to its invasiveness. They also developed genetic modification techniques for less invasive strains, and investigated genetic traits related to herbicide resistance to disease susceptibility.

Prof Chirwa explains that following a multidisciplinary approach enables the researchers to devise holistic solutions, which encompass ecological, social and economic factors, ensuring a comprehensive approach.

UP'S RAILWAY ENGINEERING RESEARCHERS EARN NATIONAL RECOGNITION

The University of Pretoria (UP)'s Chair in Railway Engineering was the winner in the category Pioneering Applied Rail Research at the inaugural South African Rail Industry Awards ceremony, instituted to celebrate 21 years of excellence by the Railway Safety Regulator (RSR). In addition, Dr Willem Sprong, the Programme Manager in the University's Chair in Railway Safety, received the Regulator's Lifetime Achievement Award. UP was also a finalist in the category Excellence in Training. The awards ceremony was held in Johannesburg on 24 October 2024.



Presenting the award to the University of Pretoria (from left): Sisa Mtwla (RSR Deputy Board Chairperson), Dr Willem Sprong, Dr David Mpye and Prof Hannes Gräbe (UP Chair in Railway Safety) and Rirhandzu Mashava (RSR Executive)

Prof Hannes Gräbe, the University's Chair in Railway Engineering, explains that railways around the world are currently undergoing a digital revolution that is fundamentally reshaping traditional practices and is challenging the long-established technologies that emerged during the eras of automated production, electronics and computing. "This shift towards digitalisation offers unprecedented opportunities to enhance the efficiency, safety and performance of railway systems." By integrating advanced systems and processes, railway operators can extract greater capability from existing assets, leading to significant improvements in capacity, operational performance and connectivity across the network.

He emphasises that the concept of smart infrastructure is at the core of this transformation. This concept involves the deployment of sensors and integrated digital communication networks to continuously monitor the current state and performance of railway assets. These sensors, which are often part of the rapidly expanding Internet of Things (IoT),

range from devices that measure simple parameters such as temperature, to advanced systems to capture high-frequency, three-dimensional acceleration data.

This rich dataset provides real-time insights into track conditions, asset health and potential risks, allowing for more informed and timely decision making.

"The ability to collect vast amounts of data is only part of the equation," he explains. The advent of big data analytics, combined with cutting-edge machine learning algorithms, enables railway engineers to move away from traditional, cyclical maintenance practices. Instead, these technologies support the implementation of condition-based and predictive maintenance strategies, where interventions are based on actual asset conditions rather than fixed time intervals. This shift not only optimises maintenance schedules, but reduces downtime, improves safety and extends the life cycle of critical infrastructure components.

The research of the Chair in Railway Engineering focuses on track infrastructure, with a particular emphasis on the use of advanced digital technologies to monitor and assess the condition of bridges, track transitions, rails, ballast and formation layers. It highlights industry-ready solutions for track infrastructure that are designed to increase capacity, enhance predictive maintenance capabilities, and extend the life cycles of various track components.



Plasma technology proves its success for water purification



The Department of Chemical Engineering's Plasma Technology Laboratory, established in 2020 with the support of the Royal Society via the Future Leader African Independent Research (FLAIR) Fellowship, is conducting groundbreaking work in terms of water purification and the removal of recalcitrant contaminants from wastewater.

The research conducted in this laboratory is supervised by Dr Samuel Iwarere (pictured above) and Prof Michael Daramola. They make use of laboratory-scale plasma units for water and wastewater treatment and have developed a pilot-scale plasma unit. Dr Iwarere explains that the plasma unit has various research applications in addition to the treatment of water, including hydrogen fuel cell research, and the sterilisation of food, the disinfection of wounds and cancer treatment.

Two recent studies examined the efficacy of plasma technology in the removal of residual pharmaceuticals from wastewater, while a mobile solar-powered water purification unit has been tested and is ready to be piloted in a local community within the Tshwane Metropolitan Municipality. This unit makes use of advanced oxidation processes to remove organic and inorganic material, as well as microorganisms from water through the combination of reaction oxygen species such as hydroxyl radicals.

REMOVING CONTAMINANTS FROM WASTEWATER

The increased consumption of analgesics and antibiotics over the past two decades has led to an increase in contaminants in wastewater. This is due to the fact that when these pharmaceuticals are taken, the entire prescribed dosage is not absorbed by the body, leaving the remaining portion to be excreted as waste. This is difficult to remove using conventional treatment approaches.

Although they are detected in very low concentrations, these emerging contaminants have become a source of concern due to their persistence in the environment. They pose risks to both aquatic life and human health. Prolonged exposure to some persistent antibiotics has been linked to developmental abnormalities, reduced reproductive success, disruptions in the balance of microbial ecosystems in aquatic environments and antibiotic resistance.

The first study that was undertaken investigated the removal of the analgesic Tramadol™ in deionised water and final wastewater effluent using a novel continuous flow dielectric barrier discharge reactor, while the second examined the degradation of the antibiotic Cefixime™ with an atmospheric air dielectric barrier discharge.

MOBILE SOLAR-POWERED WATER PURIFICATION UNIT

Since 2022, members of the Plasma Technology Laboratory have been developing an easily operated, small-scale solar-powered plasma ozonation system for the purification of water that works without chemicals. It involves the combination of plasma technology and renewable energy options to provide clean drinking water to rural, off-grid communities.

Since many villages in South Africa and the rest of Africa do not have clean running water or access to electricity, the addition of a solar energy unit to the prototype's design is very important. The villagers very often need to get their water from rivers and other contaminated sources that are not fit for human consumption. They then need to boil their drinking water to purify it. This is not energy-efficient, and does not remove all the contaminants, such as manganese, as can be done through plasma technology.

However, the unit needs a constant supply of power. This led to the idea of a unit that makes use of renewable solar-powered batteries. The laboratory-scale purification unit has already been successfully tested. It includes a plasma reactor in which water is cleaned to drinking standards as a result of the electric current that is sent through it at a high voltage, with tanks storing untreated and clean water separately. The current laboratory prototype could provide 120 l of water every four hours in off-grid situations. This is enough to serve the purposes of at least eight rural households.

NATIONAL RECOGNITION FOR MINING RESEARCH

The Department of Mining Engineering's expertise in rock engineering has once again received national recognition. During the annual awards ceremony of the South African National Institute of Rock Engineering (SANIRE), which was held in Johannesburg on 28 September 2024, the University's team walked away with three important prizes, including the highest accolade that the Institute awards. Its top researchers also earned a gold medal from the South African Institute of Mining and Metallurgy (SAIMM).

SANIRE AWARDS

Napier Award

Prof Francois Malan, Head of the Department of Mining Engineering, was awarded the Institute's Napier Award. This is the most prestigious prize to be awarded by SANIRE. It was instituted to honour the outstanding contribution to rock engineering made by Prof John Napier (an extraordinary professor in the Department of Mining Engineering) over many decades. This award is typically made every four years in recognition of distinguished contributions to the field of rock engineering. The requirements for the award include the performance of world-class research in rock mechanics over a period of many years, research that has contributed significantly to the development of aspects such as new design criteria, analysis methods, design methodologies or new technology, and extensive publication in local and international journals.

Salamon Award

Prof Francois Malan and Prof John Napier were the joint recipients of SANIRE's Salamon Award. This prize is awarded to the South African authors of the best technical paper published in 2024. Preference is given to papers published in accredited, refereed journals. Prof Napier received this award in 2012, while Prof Malan has received it on three previous occasions as a joint winner: in 2012, in 2017 and in 2018.

Ortlepp Award

Divine Ile, a master's degree graduate, who received her degree *cum laude* at the University's winter graduation ceremony in May 2024, received SANIRE's Ortlepp Award. This prize is awarded to the best technical paper to be published by a "young" South African (under 35 years) in 2024. Preference is given to papers published in accredited, refereed journals.

Student Award

Karabo Mamaregane, a final-year student in the Department of Mining Engineering, was recognised as the top university student in Rock Engineering. This award is given to students who receive the top marks in the final-year Rock Mechanics module at the University of Pretoria and the University of the Witwatersrand.

SAIMM AWARD

Gold medal

The Department's top researchers, Prof John Napier and Prof Francois Malan, also received a gold medal from the South African Institute of Mining and Metallurgy at the Institute's annual general meeting, which was held in Johannesburg on 22 August 2024. They received this award for their paper titled "Numerical simulation of large-scale pillar layouts", published in the May 2023 issue of SAIMM Journal. This medal is awarded for papers that are of a world-class standard and are judged to be publications that will become key reference works in the mining field in the future.



Prof Francois Malan



Prof John Napier



Divine Ile



Karabo Mamaregane



GROWING INDUSTRY CONNECTIONS IN TIMBER DESIGN AND CONSTRUCTION

The University of Pretoria (UP) was proud to host the second annual Timber Construction Conference, in collaboration with York Timbers and with the support of the Pretoria Institute of Architecture and the Department of Trade, Industry and Competition, at the University's Future Africa Campus. This year's event included a pre-conference colloquium and the Awards Dinner of York Timbers' annual Timber Design Competition for architecture students on 9 September, followed by the Conference on 10 September 2024.

Speaking at the Awards Dinner, Prof Themba Mosia, the University's Interim Vice-Chancellor and Principal at the time, explained that the built environment currently contributes approximately 40% of global greenhouse gas emissions, with about a third emitted during the construction phase of buildings. By developing better designs and using bio-based materials like wood in construction, we can meet the demand for new buildings, while conserving the environment, drive job creation and economic growth, and ensure that our graduates are skilled for the current and future world of work.

The Innovation @UP Growth Vision and Timber Design Competition was open to all architectural students across Africa. They were required to present conceptual plans for the vision of UP's Forestry and Agricultural Biotechnology Institute (FABI) to extend its existing FABI II Building using mass timber construction to achieve a masterful design with a low environmental impact and high operational performance. It should include spaces for collaboration, offices, laboratories, greenhouses and hydroponic towers. The competition received 31 entries of an incredibly high quality from five South African universities, including the University of Pretoria.

The pre-conference colloquium featured research conducted in UP's departments of Architecture, Civil Engineering and Engineering Management in the Faculty of Engineering, Built Environment and Information Technology, as well as the Department of Forest and Wood Science at Stellenbosch University. Interesting insights from industry were provided by York Timbers and Merensky Timber. It became clear that research and the development of new timber products and services will contribute to more equitable, sustainable forms of construction that enhance business competitiveness and promote education and skills development. By using mass timber instead of steel or concrete, strong, durable, low-carbon, fire-resistant structures can be developed for any type of building.

The Timber Construction Conference aimed to foster collaboration between government, academia and industry to promote low-carbon sustainability, competitiveness and excellence in South Africa's bioeconomy and built environment. This is aligned with the goal of government's National Development Plan (NDP) to create a prosperous country for all our people, ensure shared success, reduce inequality, harness potential, and build skills and capabilities.

Industry delegates were inspired by success stories from industry on the use of mass timber in construction, and its possibilities for design and construction. Its use not only contributes to a reduction in carbon emissions, the promotion of a circular economy and the reduced use of non-renewable resources, but also brings about savings on another valuable resource in the 21st century – time spent on construction.

The event proved to be an enlightening and collaborative gathering of industry experts, academics, government officials and thought leaders, who shared their knowledge, insights and experiences through engaging presentations, panel discussions and exciting exhibitions. It also provided a valuable platform for networking, knowledge exchange and exploring the latest innovations in timber construction.

There is a growing global interest in timber construction. The same trend is being observed in South Africa. This is largely due to the contributions of role players like the Department of Trade, Industry and Competition, Green Building Council South Africa, the important forestry research institutions, the large timber mills, architects, and the project and construction management professions.

Regenerative Public Space



With the support of the National Research Foundation (NRF), a team from the University of Pretoria and Satplan Alpha embarked on a three-year project on Regenerative Public Space (RPS) in 2022. It intended to recognise the true value of public space in cities, especially in South Africa, and contribute to uplifting changes in these spaces.

UP teams reviewed four projects to serve as case studies to illustrate the breadth and variability of regenerative public space projects. These were Moja Gabedi, Muckleneuk Commons, Burgers Park and Melusi. It is hoped that they will serve as a catalyst to promote the regeneration of public space across the City of Tshwane.

The project team then developed a digital platform to connect existing and potential future stakeholders. The portal is a Web GIS platform that functions like a typical scroll-down website. It can integrate GIS web apps into the page itself. For example, the showcase section of case study projects makes use of a dynamic background map that shifts to the location of each case study being presented.

The registration platform for RPS projects, practitioners and partners combines a location-enabled survey form that feeds into an interactive map, which highlights the spatial distribution of the respective parties across the City of Tshwane.

Each completed registration features as a colour-coded point on the map that can be clicked to open an information pop-up that describes that particular project, practitioner or partner. The registration process slowly builds a GIS map layer over time that is safely archived in the back end and is fed live into the interactive map on the portal.

The main aim of the registration platform is to foster the development of an RPS community in the City of Tshwane by establishing a spatial database of members and allowing all parties to have visual access to the database itself. By registering on the portal, projects can identify themselves in terms of their particular objectives and location. Practitioners can identify themselves in terms of their expertise and location while partners can identify themselves in terms of their areas of interest, available support and location.

Complementing the case studies' showcase and registration platform is the RPS toolkit, which provides hyperlinked access to a variety of helpful resources in the RPS space, e.g. detailed case study summaries, publications and articles, useful links, videos and selected spatial datasets.



LEARNING ABOUT GREEN INFRASTRUCTURE IN GERMANY

Postgraduate students from the Department of Town and Regional Planning had the opportunity to join their peers from the Department of Psychology in the Faculty of Humanities on an international study visit to Germany in June 2024.

The purpose of this 10-day visit was to learn more about green infrastructure projects in Germany. The visit came about through funding received from the German Academic Exchange Service (DAAD).

The visit contributed to reinforcing the students' understanding of the global problems of climate change, social inequality and infrastructure challenges at municipal and community level, which require innovative solutions from multiple perspectives.

Within the context of the United Nations' Sustainable Development Goals (SDGs), the focus of the study visit was to exchange subject-related knowledge about infrastructure (water, green spaces and transport) from an urban sustainability perspective. The emphasis was on the interaction of this knowledge with politics and governance, the economy, social inequality and climate change in relation to urban planning, psychology and sociology. Discussions between the students and lecturers on the use of social research methods to analyse infrastructure arrangements formed an important element of the visit.

Automated crocodile detection using deep learning and synthetic data

Marchant Fourie, Prof Herman Myburgh and Dr Allan de Freitas

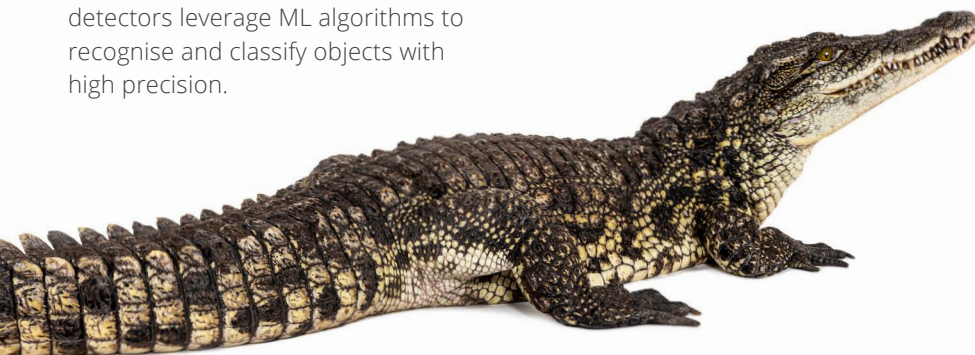
The use of Artificial Intelligence (AI) to create a more efficient and inclusive society is gaining momentum and will soon not only transform business, education and health care in Africa, but also farming and wildlife management. A master's research project conducted in the Department of Electrical, Electronic and Computer Engineering's Smart Sensing and Intelligent Systems Research Group is making use of synthetic data to develop a machine learning (ML) model to identify crocodiles from aerial images.

In recognition of the problem encountered by wildlife managers who need to perform population counts or locate crocodiles in game parks and nature reserves in dangerous situations, an ML model was developed using deep learning neural networks to train an image object detector to locate these reptiles using unmanned aerial vehicles (UAVs) or drones. These detectors leverage ML algorithms to recognise and classify objects with high precision.

This capability is particularly valuable in situations where the accurate and efficient detection of animals is crucial. While this technology reduces the cost and time required to perform animal surveys, a major challenge is the large amount of data required to train the network. This is a problem if the target animal is scarce, and there is no available data on which to train the model.

A major limitation of deep learning is that it involves acquiring and annotating substantial datasets for model training. For this reason, the researchers decided to make use of synthetic data as an alternative method of data generation. Synthetic images were generated through computer-based tools such as those used for game development to create realistic-looking environments for the purpose of training the image models. This included the use of a virtual camera.

The research results showed that this approach could deliver a similar object detection model as one developed with live animals, and that wildlife managers would still be able to successfully identify the reptiles in an identified area for management purposes.



DO YOU KNOW ABOUT DARK DATA?

The rapid evolution of ICT, coupled with globalisation and digitalisation, has led to a vast network of inter-connected devices, which contribute to the exponential growth of data. While big data offers organisations valuable insights and opportunities, it also presents significant challenges.

One pressing concern is the environmental impact of data storage, with data centres contributing to 2% of global greenhouse gas emissions. They are also projected to consume up to 4% of global electricity by 2030. The concept of digital decarbonisation has emerged as a critical focus, which aims to reduce the carbon footprint associated with digital storage and processing.

A key aspect of this effort lies in the management of dark data – the masses of unused information that, if effectively leveraged through knowledge management practices, artificial intelligence (AI) capability and machine learning (ML) models, could support sustainability goals.

Dark data often includes unstructured data from sources like emails, old documents and logs, which remain hidden or unused. As organisations store more data without effective management, dark data grows, leading to increased storage needs and inefficiencies.

UP researchers in the School of IT are studying dark data management as a catalyst for digital decarbonisation.

Prof Hanlie Smuts

Remembering Professor Philip Savage

Philip Savage passed away on 5 August 2024, less than a month before he would have reached the age of 103 years. The Faculty honours a celebrated civil engineer, who had a significant influence on his discipline, both as a government official and private practitioner, and later as a professor at the University of Pretoria.

Philip and his twin brother John qualified as civil engineers from the University of the Witwatersrand (Wits University) in 1943. Philip started working with the former Transvaal Roads Department. A few years later, both brothers were recruited separately by Polla van Niekerk of VKE fame to assist him on a number of projects in Central Africa. John, who passed away in 2020, left the firm reasonably early on, while Philip stayed on in a senior position in the Pretoria office after the work in Central Africa was completed. In 1970 he accepted a professorship at the University of Pretoria (UP).

After two years with the Transvaal Roads Department, Philip was encouraged to apply for the Iscor/Satmar bursary for postgraduate studies in engineering, which he was awarded. After obtaining his master's degree in geotechnical engineering from Wits University, he joined the Pretoria City Engineer's Department in 1948, from where he was recruited in 1949 by Van Niekerk.

Probably the first project VKE embarked on in Central Africa was the 50-mile-long road between Kafue and Chirundu in the then Northern Rhodesia. Before going up north, Philip spent a while in the Pretoria office, inter alia designing a road in the Western Transvaal. He got married before going north and took his new bride, Ann, with him, travelling by train to Lusaka.

Towards the end of the project, Philip was offered a job by the Nyasaland

Government, where he stayed for two years. On returning to VKE in 1957, he spent seven years in the Salisbury office before relocating to Pretoria in 1964. Back in South Africa, he worked on light pavement structures in the Western Transvaal from 1965. These roads played a major role in the economic development of that part of our country. During this period, Philip's wife Ann contracted cancer and passed away in the late 1960s, leaving behind Philip and two daughters.

Circa 1968, the head of VKE's laboratory, Soillab, resigned and Philip was asked to take overall control of the laboratory and all the other geotechnical activities. In 1970, he was offered and accepted a professorship in geomechanics and road construction in UP's Department of Civil Engineering. One of the feats of Philip's professorship was his ability to teach the intricacies of soil mechanics in Afrikaans shortly after acceding to the chair, despite his home language being English.

After retiring in 1986, he was still engaged in providing lectures to postgraduate students, often deviating from the curriculum to share his pet hobbies. These were compaction, stabilisation and the constitution of granular material; topics on which he presented papers at the Southern African Transport Conference (SATC) until well into his 90s, where he received an Honorary Fellowship in recognition of his support of the conference and sharing knowledge as a practical academic.



Prof Philip Savage

He also shared his knowledge by giving continuing education courses in compaction and soil stabilisation, as well as acting as a specialist consultant in this field.

Philip's family wish to share the following words regarding "The Prof": You can shed tears because I've gone, or you can smile because I've lived; You can turn your back on tomorrow and live yesterday, or you can be happy for tomorrow because of yesterday; You can remember only that I have gone, or you can cherish my memory and let it live on. You can cry and close your mind and feel empty, or you can smile, open your heart, love and live on.

To a great man who leaves a wonderful legacy, not only to his daughters, grandchildren and great-grandchildren, but to all who have benefitted from his knowledge and wisdom, and not least the engineering scholarship in his name, rest in peace.

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