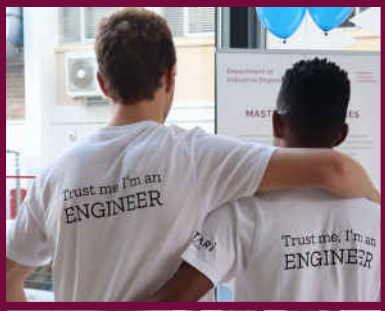
Stellenbosch
UNIVERSITY
IYUNIVESITHI
UNIVERSITEIT

Engineering
Eyobunjineli
Ingenieurswese

2023 | ANNUAL REPORT JAARVERSLAG



forward together
sonke siya phambili
saam vorentoe

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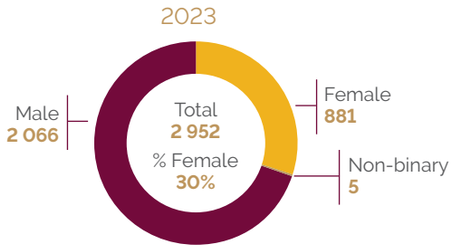
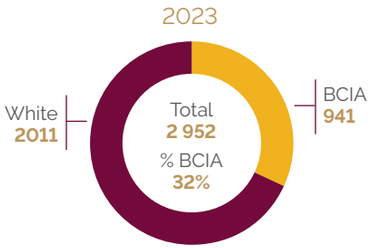
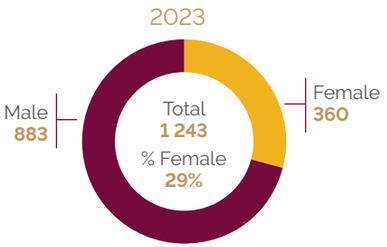
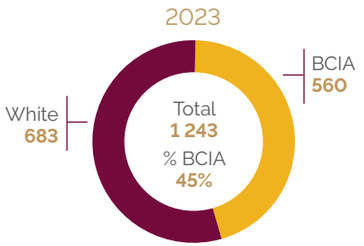




Postgraduate Student **Demographics**

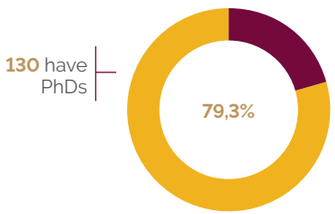


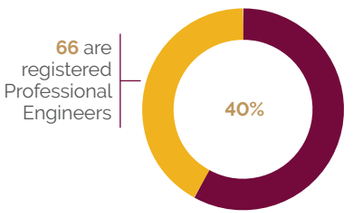


BCIA = black African, coloured, Indian and Asian

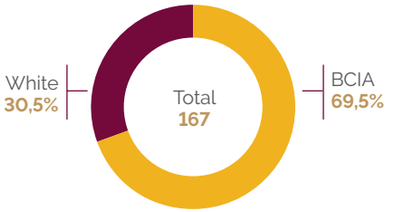
Academic Staff

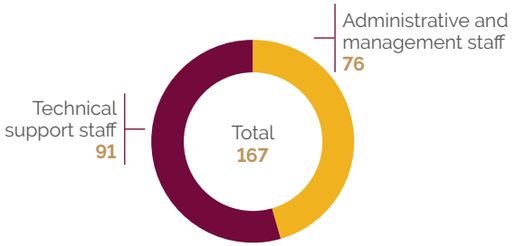
164 permanent academic staff





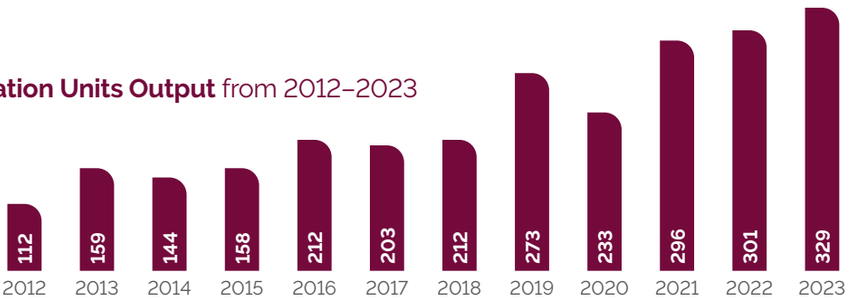
Support Staff





792 Graduates (Dec 2023 & March 2024)

Publication Units Output from 2012–2023



54 NRF-rated Academics 2023

From the Dean

Stellenbosch University's Faculty of Engineering is well-resourced, with outstanding staff and students committed to developing South Africa's economy and improving the quality of life for all its citizens.

Maintaining a tradition of quality education, our professional BEng programmes have once again been fully accredited by the Engineering Council of South Africa. In the year under review, we added 40 postgraduate diploma graduates, 476 graduate engineers, 247 master's graduates, and 60 doctorates to the engineering profession.

To meet a worldwide need for fire and data engineers, the Faculty registered two new focus areas for structured master's programmes with the South African Qualifications Authority. One is the focus area in Fire Engineering for the MEng in Civil Engineering, and the other is the focus area in Data Analytics for the MEng in Chemical Engineering.

Load shedding remained a challenge in 2023. The Electricity Crisis Committee recommended that the starting time of all second-semester lectures be moved to ten minutes past the hour to allow our generator to kick in without disrupting lectures, as load shedding usually starts on the hour. With the University's support, load shedding had a minimal impact on the Faculty's operation, and we successfully completed the academic year.

We have much to celebrate, and below we present a few highlights according to the University's core strategic themes.

A thriving Stellenbosch University

The ongoing Engineering Campus Renewal project has reached a significant milestone with the inauguration of the updated Industrial Engineering and Mechanical and Mechatronic Engineering (M&M) buildings. After being relocated for renovations, the Department of Civil Engineering has also returned to its upgraded facilities at the start of the academic year. The project's total cost is expected to exceed R1 billion, making it the most expensive venture in the University's history.

To help diversify our student body, our student recruiter, Mr August Engelbrecht, enlisted fifteen current engineering students to reach out to provisionally accepted prospective students in their mother tongues via telethon. They provided insider perspectives on university life. Additionally, the Faculty attracted ten talented learners from various provinces who achieved above 85% in their National Senior Certificate examinations for the 2024 academic year.

A transformative, inclusive student experience

The Faculty provides high-quality services to ensure student success. In addition to computing facilities in the newly refurbished M&M building, the Faculty of Engineering Computer User Area (FECUA) offers student support services via its new website. The user-friendly access to services includes reporting technological issues at the Help Desk, looking up timetables or booking an e-classroom. The approval of another technical officer position enhanced FECUA's capacity. Longtime technical officer Mr Bennie Lindoor received the Administrative Employee of the Year 2023 award for service excellence.

Networked and collaborative teaching and learning

Our investment in collaborative initiatives enhances professionalisation and student learning experiences. Under the capable leadership of Prof Celeste Viljoen, vice-dean of teaching and quality assurance, the hard work of the Faculty's departmental chairs and programme coordinators to prepare a high-quality, refreshed programme offering for accreditation paid off. After a rigorous auditing process, our BEng programmes have again been fully accredited by the Engineering Council of South Africa, valid up to 2028. This statutory body ensures that graduates receive qualifications supporting their registration as professional engineers, locally and abroad.

Research for impact

Two new research chairs were established in the Faculty to focus on real-world applications and strengthen our capacity for progress and innovation in engineering. The Sasol-NRF (National Research Foundation) Research Chair in Green Hydrogen: Integration and Transition, awarded to Prof Prathieka Naidoo from the Department of Chemical Engineering, aims to investigate the role of green hydrogen in a diversified energy mix. The SARChI NRF Research Chair in Power System Simulation, awarded to Prof Bernard Bekker from the Department of Electrical and Electronic Engineering, is strategically situated to leverage the Department's expertise in renewable energy and power system simulation for national power system planning and operations.

Purposeful partnerships and inclusive networks

Strategic partnerships ensure local relevance, regional impact and a global reach. Dr Jacques Kruger of the Department of Civil Engineering, with expertise in 3D-printed concrete technology, helped develop and present the first International Summer School on Additively Manufactured Concrete Structures in Capri, Italy.

Likewise, Prof Thinus Booysen of the Department of Electrical and Electronic Engineering collaborated with the Technical University of Munich in Germany to develop a solar-powered electric tractor for African farmers, dramatically reducing carbon emissions. The Department of Science and Innovation funded the project through SANEDI and the European Union as part of the bigger SolChargE project.

> *"We proactively shape our future and confidently face it, dedicated to serving society.*

Stellenbosch University as an employer of choice

Our staff's contributions were noted and recognised in various ways. Seven academic staff members received NRF ratings, bringing the number of rated researchers to 53. Department of Civil Engineering members Prof Nico de Koker and Dr Johann Andersen were confirmed as SAICE fellows.

Ms Janine Myburgh of the Department of Civil Engineering received the prestigious Phenomenal Woman in Management Award for her commitment and loyalty to the Pniel Heritage and Cultural Trust.

Two newly appointed professors presented inaugural lectures: Prof Riaan Combrinck (Department of Civil Engineering) and Prof Herman Engelbrecht (Department of Electrical and Electronic Engineering).

Prof Corné Schutte, the current chair of the Department of Industrial Engineering, was appointed the new vice-dean for research and industry liaison. Prof Joubert van Eeden replaced him as chair. Prof Cristina Trois, an internationally recognised leader in environmental engineering, was appointed as the new director of the Centre for Renewable and Sustainable Energy Studies.

Looking forward

Through the continuous enhancement of the Faculty's programme offering and facilities, we proactively shape our future and confidently face it, dedicated to serving society.

Prospective engineering students who excelled in their NSC exams, proudly standing with the Dean of the Faculty of Engineering (middle).

Van die Dekaan

Die Universiteit Stellenbosch se Fakulteit Ingenieurswese is goed toegerus en het uitnemende personeel en studente wat hul toewy aan die ontwikkeling van Suid-Afrika se ekonomie en die verbetering van al sy burgers se lewensgehalte.

Getrou aan 'n tradisie van uitnemende opvoeding is ons professionele BIng-programme weereens ten volle geakkrediteer deur die Ingenieursraad van Suid-Afrika (ECSA). In die oorsigjaar het ons 40 nagraadse diplomandi, 476 gegradueerde ingenieurs, 247 magistergraduati en 60 gedoktoreerdes tot die ingenieursberoep toegevoeg.

Om in die globale behoefte aan brand- en dataingenieurs te voorsien, het die Fakulteit twee nuwe fokusareas vir gestruktureerde magisterprogramme by die Suid-Afrikaanse Kwalifikasie-outoriteit geregistreer. Een is die fokusarea in Brandingenieurswese vir die MIng in Siviele Ingenieurswese, en die ander is die fokusarea in Data-analise vir die MIng in Chemiese Ingenieurswese.

Beurtkrag was steeds 'n uitdaging in 2023. Die Elektrisiteitkrisiskomitee het aanbeveel dat die begintyd vir alle tweedesemestermodules aangeskuif word na tien minute oor die uur om ons kragopwekker 'n kans te gee om in te skop sonder om lesings te ontwrig, aangesien beurtkrag gewoonlik op die uur begin. Met die Universiteit se ondersteuning het beurtkrag min invloed op ons bedrywighede gehad en kon ons nog 'n akademiese jaar suksesvol afhandel.

Ons het heelwat om te vier. Vervolgens word 'n paar hoogtepunte kortliks aangebied, ingedeel onder die Universiteit se kern strategiese temas.

Me Janine Myburgh, senior administratiewe beampte van die Departement Siviele Ingenieurswese, ontvang die Kaapse Wynlanddistrikmunisipaliteit se Fenomenale Vrou in Bestuur-toekenning.

'n Florerende Universiteit Stellenbosch

Die voortgaande Ingenieurswese-Kampus-vernuwingsprojek het 'n beduidende mylpaal bereik met die inwyding van die gemoderniseerde geboue vir Bedryfsingenieurswese en Meganiese en Megatroniese Ingenieurswese. Na hul hervestiging tydens die opgraderings, het die Departement Siviele Ingenieurswese ook teruggekeer na hul gemoderniseerde fasiliteite. Die projek se algehele koste sal na verwagting R1 miljard beloop, wat dit die duurste onderneming in die Universiteit se geskiedenis maak.

Om ons studenteliggaam te help diversifiseer, het ons werwingsbeampte, mnr August Engelbrecht, vyftien ingenieurstudente ingespan om via teleton uit te reik na voorwaardelik aanvaarde voornemende studente in hul moedertaal. Hulle het binneperspektiewe op die universieitslewe verskaf. Boonop het die Fakulteit vir die 2024 akademiese jaar tien talentvolle leerders wat meer as 85% vir hul Nasionale Senior Sertifikaat behaal het, gelok.

'n Transformerende studente-ervaring

Om studentesukses te verseker, lewer die Fakulteit hoëgehaltedienste. Benewens rekenaarfasiliteite in die nuutopgegradeerde M&M-gebou, stel die Fakulteit Ingenieurswese Rekenaargebruikersarea (FIRGA) studentesteundienste via sy nuwe webwerf beskikbaar. Hierdie gebruikersvriendelike toegang tot dienste behels die aanmelding van tegnologieprobleme by die Hulptoonbank, die naslaan van roosters of die bespreking van 'n e-klaskamer. Die goedkeuring van nog 'n tegniesebeamptepos vergroot FIRGA se kapasiteit. Die tegniese beampte mnr Bennie Lindoor het die toekenning Administratiewe Beampte van die Jaar 2023 vir sy uitnemende langtermyndiens gekry.

Genetwerkte en samewerkende onderrig en leer

Ons belegging in samewerkingsinisiatiewe versterk professionalisering en studenteleerervarings. Onder die bekwame leierskap van prof Celeste Viljoen, visedekaan vir onderrig en gehalteversekering, het die departementele voorsitters en programkoördineerders se harde werk om 'n hoëgehalteprogramaanbod te vernuwe en vir akkreditasie voor te lê, vrugte afgewerp. Na afloop van 'n nougesette ouditeringsproses is ons BIng-programme weer tot en met 2028 ten volle deur ECSA geakkrediteer. Hierde statutêre liggaam verseker dat gegradueerdes kwalifikasies verwerf wat hul registrasie as professionele ingenieurs plaaslik en internasionaal steun.

Navorsing vir impak

Twee nuwe navorsingsleerstoele is in die Fakulteit gevestig om op werklike toepassings te fokus en ons kapasiteit vir vooruitgang en innovasie in ingenieurswese uit te bou. Die Sasol-NNS (Nasionale Navorsingstigting) Navorsingsleerstoel in Groen Waterstof, toegeken aan prof Prathieka Naidoo van die Departement Chemiese Ingenieurswese, beoog om die rol van groen waterstof in 'n gediversifiseerde energiesamestelling te ondersoek. Die SARChI NNS Navorsingsleerstoel in Kragstelselsimulasie, toegeken aan prof Bernard Bekker van die Departement Elektriese en Elektroniese Ingenieurswese, is strategies geleë om die Departement se kundigheid in hernubare energie en kragstelselsimulasie aan te wend vir die beplanning en bedryf van nasionale kragstelsels.

Doelgerigte vennootskappe en inklusiewe netwerke

Strategiese vennootskappe verseker plaaslike relevansie, streeksimpak en 'n globale reikwydte. Dr Jacques Kruger van die Departement Siviele Ingenieurswese, met kundigheid in 3D-gedrukte-beton-tegnologie, het gehelp om die eerste internasionale somerskool oor byvoegend vervaardigde betonstrukture in Capri, Italië, te ontwikkel en aan te bied.

Insgelyks het prof Thinus Booysen van die Departement Elektriese en Elektroniese Ingenieurswese in samewerking met die Tegniese Universiteit van München in Duitsland 'n sonkrag elektriese trekker vir Afrika-boere ontwikkel wat koolstofuitlaatgasse dramaties verminder. Die Departement van Wetenskap en Innovasie het die projek deur SANEDI en die Europese Unie as deel van die groter SolChargE-projek befonds.

> *"Ons beïnvloed die toekoms proaktief en gaan dit in diens van die gemeenskap met vertroue tegemoet.*

Die Universiteit Stellenbosch as voorkeurwerkgewer

Ons personeel se bydraes is raakgesien en op verskeie maniere erken. Sewe akademiese personeellede het NNS-graderings ontvang, wat die aantal gegradeerde navorsers op 53 te staan bring. Lede van die Departement Siviele Ingenieurswese, prof Nico de Koker en dr Johann Andersen, is as SAISI-genote bevestig.

Me Janine Myburgh van die Departement Siviele Ingenieurswese, het die voortreflike Fenomenale Vrou in Bestuur-toekenning vir haar toewyding en lojaliteit aan die Pniel Erfenis- en Kultuurtrust ontvang.

Twee nuutaangestelde professore het intreeredes gehou: prof Riaan Combrinck (Departement Siviele Ingenieurswese) en prof Herman Engelbrecht (Departement Elektriese en Elektroniese Ingenieurswese).

Prof Corné Schutte, die voorsitter van die Departement Bedryfsingenieurswese, is aangestel as die nuwe visedekaan vir navorsing en bedryfskakeling. Prof Joubert van Eeden vervang hom as voorsitter. Prof Cristina Trois, 'n internasionaal erkende leier in omgewings-ingenieurswese, is die nuwe direkteur van die Sentrum vir Hernubare- en Volhoubare-energiestudies.

Toekomsblik

Deur die Fakulteit se programaanbod en fasiliteite deurlopend te moderniseer, beïnvloed ons ons toekoms proaktief en gaan dit in diens van die gemeenskap met vertroue tegemoet.

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DEPARTMENT OF **CHEMICAL ENGINEERING**

Chemical engineering is central to developing industrial processes that are safe, sustainable and profitable. By using our planet's bioresources optimally, we help ensure a sustainable future. Our dedicated academics are active researchers who teach students how to use state-of-the-art laboratory equipment to develop beneficial processes and implement the technology in full-scale production. Above, Mellisa Ncube and Dr George Mbella Teke examine the phase separation in solvent extraction, separating biosurfactants from the fungal biomass that produced them. The resulting purified mannosyl erythritol lipids can be used in skincare products to treat eczema and psoriasis.

Left: Qiniso Ngiba, a master's graduate in Chemical Engineering, is one of the two South African winners of the Blue Sky Young Researchers Innovation Award.
Right: Beatrice Mwamba (right) received the Minerals Education Trust Fund Award for the Best Final-Year Project from Prof Eugene van Rensburg. At the same event, she was also recognised for obtaining her BEng in Chemical Engineering with distinction in 2022.

Chemical Engineering graduates **prove their mettle**

Chemical engineering graduates – Qiniso Ngiba and Beatrice Mwamba – are already making strides in their fields.

Top achiever Qiniso Ngiba was one of two South African winners of the International Council of Forest and Paper Association's Blue Sky Young Researchers Innovation Award for climate-positive forestry, clean manufacturing and the forest bioeconomy. Finalist Ngiba's master's project competed against 12 other representatives from seven countries in the Association's CEO Global Roundtable.

Qiniso investigated spent pulp liquor to synthesise soil conditioning materials to improve soil quality under the supervision of Profs Luvuyo Tyhoda (Wood Science) and Johann Görgens (Chemical Engineering).

Beatrice Mwamba, a cum laude graduate in Chemical Engineering, was a finalist in the Integrated Post Graduate Industry Partnership (IPGIP) competition. Her innovative final-year project involved creating soap from waste cooking oil and citrus peel, offering a green solution to waste valorisation. Mwamba's dedication and initiative in her final-year project were highly praised by her supervisor, Mr Zwonaka Mapholi. She also integrated well into the Institute of Plant Biotechnology team, which hosted her for part of her project.

After her studies, Mwamba joined Zutari's graduate programme, aiming to specialise in water treatment and grow under expert mentorship.

Postgraduates swap lab coats for scorecards

Postgraduates from the Department of Chemical Engineering took a break from their research to serve as judges at the Regional Eskom Expo for Young Scientists, which was held at Paul Roos Gymnasium in August. Dr George Teke, a postdoctoral researcher, along with master's candidates Alex Brock, Warren Fleming and Veronica Lourens, had the opportunity to evaluate the scientific investigations presented by school learners.

Dr Teke described the experience as fun and interesting, while Lourens found it very insightful to witness the capabilities of the new generation.

Our staff and researchers pack an **international punch**

The diverse participation of our researchers in high-profile conferences demonstrates the global reach and impact of the research conducted in the Department of Chemical Engineering at Stellenbosch University.

After a five-year hiatus because of the COVID-19 pandemic restrictions, Prof Cara Schwarz, who received a National Research Foundation B-rating in recognition of her high-quality research output, presented a paper at the first Properties and Phase Equilibria for Product and Process Design (PPEPPD) held in Spain. This is an effective forum on the status and future trends in properties and phase equilibria that are important to designing products and processes in chemical thermodynamics. Three students exhibited posters.

Prof Prathieka Naidoo attended the 26th International Conference on Chemical Thermodynamics (ICCT) in Osaka, Japan, and presented a paper at the 12th International Workshop on Advances in Cleaner Production (IWACP) in Stellenbosch.

Profs Johan Görgens and Eugéne van Rensburg and their students attended the Alternative Fuels and Chemicals Coalition's third annual Global Biobased Economy Conference and Exhibit in Washington, DC. They presented a paper and exhibited three posters on the development of waste-to-ethanol technology to promote a circular economy. Moreover, their students delivered three papers at the International Bioenergy and Bioproducts Conference in Atlanta.

The five-year South Africa-Norway Cooperation on Ocean Research (SANOCEAN) supported ten projects that focused on the mutual priorities of the blue economy, climate change, the environment and sustainable energy. At the concluding conference held in Oslo, Norway, Prof Guven Akdogan presented the project on the factors influencing the formation, fate and transport of microplastic in marine coastal ecosystems.

Prof Neill Goosen and Prof Robbie Pott attended the 14th European Congress of Chemical Engineering and the 7th European Congress of Applied Biotechnology in Berlin, Germany, and the International Seaweed Symposium in Hobart, Tasmania.

New structured MEng in Chemical Engineering: **Data Analytics**

The Department of Chemical Engineering introduces a Data Analytics focus area to its MEng programme, with the first intake in 2024. The focus area will equip chemical engineers with the fundamentals of data science and enable them to apply newly developed methods to large, integrated industrial processes, increasing productivity and efficiency.

> *"To accommodate working engineers, the programme is offered in hybrid mode, full-time over two years or part-time over three years.*

Prof Louw, programme leader and specialist in machine learning for process monitoring and control, explains the need for this new focus: "Our colleagues in the chemical processing industry recognised the value of data science to support their operations when optimising or troubleshooting processes. However, they soon realised that the 'standard' data science techniques were not well suited to the type of data typically generated by a chemical plant. They need chemical engineers with the fundamental understanding to adapt the methods to suit their needs."

The curriculum, specific to the process industry, covers a variety of topics ranging from plantwide dynamics to applied machine learning, and more. By focusing on the fundamentals of machine learning, it encourages engineers to understand the methods they employ rather than implement black-box solutions.

The programme receives welcome support from industry, with Sasol, a chemicals and energy company, contributing financially. Stone Three, a company offering end-to-end digital solutions for heavy industries, contributes highly prized industrial experience through their specialists' presentation of some modules.

To accommodate working engineers, the programme is offered in hybrid mode, full-time over two years or part-time over three years. Students may attend the eight taught modules' block week in person on campus or remotely in real time. They work on assignments in their own time. Finally, students undertake a research project on a complex, relevant problem in process data analytics under the individualised supervision of an expert in the field.

New SARChI Research Chair to leverage green hydrogen

Prof Prathieka Naidoo of the Department of Chemical Engineering has been awarded the Sasol-National Research Foundation (NRF) Research Chair in Green Hydrogen Integration and Transition to enhance research and postgraduate training.

This is the Department's second research chair under the South African Research Chairs Initiative (SARChI), the other being the Research Chair in Sugarcane Biorefineries under Prof Johann Görgens. Prof Naidoo highlighted the strong synergy in the projects under these chairs: "Both target existing hard-to-abate manufacturing operations, decarbonising industries within the timeframes of 2030 to attain net-zero by 2050, identifying feasible technology routes in green fuels production and applying a systems integrated engineering approach in identified industrial economic zones."

Through SARChI, the NRF funds chairs for five-year periods in select fields to expand South Africa's scientific research and innovation capacity. This improves our international competitiveness while responding to the country's social, economic and transformation needs. Ultimately, we will attract excellent researchers and scientists to this field, increasing our master's and doctoral graduates.

The new chair is set to contribute to South Africa's Green Hydrogen Programme and support the United Nation's Sustainable Development Goals and COP26 targets. Aligning with global energy diversification efforts, it will collaborate with various University faculties and external partners to advance renewable energy and sustainability. Prof Naidoo said the work under the Green Hydrogen Chair would involve a collaborative effort with researchers from the Faculty of Engineering, School of Data Science and Computational Thinking, School of Climate Studies, the Water Institute and other local and international researchers and businesses. The chair is strengthened by having support from the Centre for Renewable and Sustainable Energy Studies (CRSES) and by aligning with the joint initiative of the departments of Chemical Engineering, Electrical and Electronic Engineering, Industrial Engineering, and Mechanical and Mechatronic Engineering to promote research in the field of green hydrogen through funding received from the University's Strategic Fund.

Prof Naidoo is enthusiastic about the transformation of the South African energy sector and the global changes around diversifying energy sources: "It's a truly exciting time to be in this research space of renewables, energy security and sustainability!"

Prof Prathieka Naidoo

Research **Output**

58	2	1	7	37
Subsidised Journal Articles	International Proceedings	Chapters in Books	Doctorates	Master's Degrees

Research **Themes**

Extractive Metallurgy

The sustainable production of valuable minerals and metals from ore or metal-containing waste material is critical for a sustainable future. Extracting the metal values from natural ores bodies and complex engineered wastes requires various treatment processes. The group undertakes research into the fundamentals and application of such treatment processes. Key challenges include the changing characteristics of raw materials due to depletion of easy-to-process ore bodies, dealing with complex metal structures and associations in engineered wastes, and ensuring that new and existing extraction processes minimise energy and water use.

Separations Technology

The Separations Technology research group focuses on understanding the fundamentals and thermodynamics of separation processes involving hydrocarbons and other chemicals. Typical processes include distillation, liquid-liquid extraction, adsorption, supercritical fluid fractionation and membrane separation. Much of the work focuses on separating compounds where the underlying systems may exhibit azeotropy and association due to hydrogen bonding and where the systems may involve molecules with varying polarity and asymmetrical structure.

Bioresource Engineering

We can transition toward a more sustainable future by optimally using our available bioresources. This group focuses on developing industrial bioprocesses that are safe, sustainable and profitable, either by employing biological resources (e.g. live organisms or active biological molecules) to transform raw materials into valuable products, or by using biological raw materials as inputs into processes. A robust interdisciplinary approach leads to frequent collaboration with other disciplines at Stellenbosch University and leading international institutions.

Water Technology

The group focuses on research and development to address local and international challenges in water provision by improving existing water treatment technologies and developing new technologies. The group's strengths include membrane technology (microfiltration, ultrafiltration, reverse osmosis, forward osmosis, membrane distillation and Donnan dialysis) and technologies suitable for developing economies. Current projects range from investigation and modelling of basic phenomena to technology development leading to implementation in the field.

Process Monitoring and Machine Learning

Advances in online monitoring and data collection present an opportunity to enhance chemical engineering processes' efficiency, sustainability, and profitability. This group's expertise rests in applying machine learning techniques to improve the operation and control of chemical plants, emphasising industry-ready solutions. Applications include fault detection and diagnosis, causality analysis, operational state identification and actionable advisories.

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2023–2024 Engineering **Student Council**

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Chair

Ntseliseng Makoala
Vice-Chair

Shalmé Barnard
Secretary

Lufuno Managa
Mental Health and Social Impact

Jordi Swartz
First-Year Mentor and Mental Health

Kimayar Naidoo
Transformation, Women and Queer Empowerment

Karabo Modiba
Treasurer

Callum Wilcox
Marketing and Merchandise

Sybrand de Waal
Sustainability and Industrial Liaison

Tshedza Nephali
Events Coordinator and First-Year Mentor

Taro Samuelson
International Students and Postgrad

Ankia Burger
Engineering Ball and Industrial Liaison

DEPARTMENT OF **CIVIL ENGINEERING**

The fast-changing civil engineering industry worldwide demands engineers who can devise original solutions to keep pace with new technology and evolving requirements. The Department of Civil Engineering is dedicated to producing graduates capable of meeting these challenges by keeping its academic offering relevant to present-day needs. Therefore, research forms a crucial part of the Department's activities, leveraging state-of-the-art laboratory facilities to develop innovative solutions. In the image above, Mr Kasozi is using a point laser to measure deformation following the completion of several load cycles on asphalt test specimens by the mobile load simulator, which was invented by Prof Fred Hugo and Mr Johan Muller.

Dr Jacques Kruger (left), designer of the first industrial-grade gantry-type 3D concrete printer in Africa, at the Department's large-scale 3D concrete printing facility with Prof Gideon van Zijl and postgraduate students Rue Munemo, Mustapha Jaji, Kamoru Ibrahim, and Jean-Pierre Mostert.

Civil Engineering academics involved in the first global **3D concrete** printing Summer School

The notable growth in technology enabling fast and efficient 3D concrete printing in construction creates demand for skilled engineers in this emerging field. To upskill engineers, the first in a planned series of international summer schools on Additively Manufactured Concrete Structures took place in Capri, Italy. Dr Jacques Kruger, a senior lecturer in the Department of Civil Engineering, was invited to be one of four lecturers tasked with developing a curriculum for the school's 3D concrete printing course.

The summer school attracted interest globally. Thirty PhD students and industry leaders, including former and current Department students, completed the course.

Prof Costantino Menna from the University of Naples Federico II hosted the event sponsored by the International Federation for Structural Concrete and the International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM).

Dr Kruger started his PhD in 3D concrete printing in 2017 under the supervision of Prof Gideon van Zijl, who initiated 3D concrete printing research at the Department. Dr Kruger successfully designed and manufactured Africa's first industrial-grade gantry-type 3D concrete printer.

To date, the Sustainable Infrastructure research group has produced pioneering research, publishing more than 50 international research papers in high-impact factor journals and graduating more than 35 BEng, nine master's and 13 PhD students. They have also designed and built a larger, 16 m² build volume 3D concrete printer equipped with a large, automated silo for continuous printing and a state-of-the-art end effector that allows real-time functional grading of the printing material.

Local industry partners contributed in-kind sponsorship, ranging from construction materials to industry representative bodies, while the national Department of Science and Innovation (DSI) provided funding.

"Development of the facilities by the PhD students has been key to fundamental understanding and technological innovations. Team members have received prizes for innovation," says Dr Kruger. "Ultimately, we aim to unlock the true potential of additively manufactured concrete technologies and transform the largely unindustrialised global construction sector into a smart, sustainable and lucrative industry."

Taming rushing water to **protect the environment**

Dr Adèle Bosman

Dr Adèle Bosman, a seasoned civil engineer with over 15 years of experience in the water engineering industry, specialises in river hydraulics and dam engineering. Since scouring and erosion problems downstream of dams particularly interest her, the 12th ICOLD European Club Symposium was the perfect opportunity to present her groundbreaking research.

Held in Interlaken, Switzerland, the symposium brought industry peers together to grapple with the challenges posed by adapting to changes in energy, climate, legislation and ageing dams. The symposium provided a platform to discuss technical subjects related to dams. The event also celebrated the 75th anniversary of the Swiss Committee on Dams, offering insights into Switzerland's dam development history and perspectives on safer energy transition.

Dr Bosman's presentation at the symposium addressed a critical gap in dam safety design. Her research rendered valuable insights by combining physical and numerical modelling to predict the equilibrium geometry of scour holes caused by plunging jets in bedrock downstream of high dams.

Under her supervision, two exceptional PhD candidates, Drs Claudia McLeod and Henry-John Wright, contributed significantly to the field of hydraulic engineering. Dr McLeod's research focused on optimising sand traps and settler designs for efficient deposition of suspended sediment. Through three-dimensional numerical modelling, she offered a sustainable solution for sediment management by establishing guidelines to enhance efficiency and reduce length requirements.

Dr Wright's research investigated novel deflector shapes for uncontrolled spillways to increase safe unit discharge. His study identified effective deflector shapes by combining physical and numerical modelling, offering solutions for spillways over 150 m in height and unit discharges between 100 and 200 m³/s/m.

Both Drs McLeod and Wright's research offered practical solutions to complex problems in water management.

Young researchers on a **quest for circularity**

The Young Concrete Researchers, Engineers and Technologists Symposium (YCRETS) was created by Cement and Concrete SA (CCSA) to invest in the future of young researchers and ensure succession planning. The event brought together individuals aged 35 and younger who are developing, designing and applying concrete- and cementitious-based materials in Southern Africa.

Desiring to bridge the gap between industry and academia, several academics from the Department of Civil Engineering became actively involved in CCSA's endeavours. After the successful inaugural YCRETS 2021 hosted by Wits, CCSA invited Stellenbosch to host and assist with organising YCRETS 2023. As the custodians of YCRETS, CCSA worked closely with a committee comprising the academic staff of Stellenbosch University and ensured that all papers were reviewed by a scientific committee and complied with conference requirements for authoritative research.

Twenty-two research papers were presented at YCRETS 2023, with the symposium's theme of circularity strongly emerging. The theme emphasised the quest among young researchers to find innovative ways to minimise the impact of cement and concrete on the environment while meeting the demands for sustainable and resilient infrastructure.

Dr Wibke de Villiers, a member of the YCRETS 2023 organising committee, summarised her experience: "Some of the impacts of YCRETS 2023 are immediately tangible, such as the research shared and ideas exchanged – but the most exciting impact is the connections created that will develop into invaluable relationships in years to come. YCRETS provides our young researchers a key opportunity to build their professional networks in the cement and concrete industry."

Practical solutions for a **fiery problem**

Dr Natalia Flores-Quiroz was appointed as a full-time senior lecturer and took on the development of our new, structured master's programme in Fire Engineering. She has been working as a postdoctoral fellow for the past few years and brings with her extensive industry experience and a master's degree in Fire Safety from Ghent University.

Dr Flores-Quiroz has left a lasting impression with her work in fire engineering research. She was born and raised in Chile and began her career as a qualified electrical engineer. After working as a fire safety engineer for six years, she transitioned to academia and pursued a master's degree in Belgium.

After completing her master's degree in Fire Safety, Dr Flores-Quiroz sought opportunities to broaden her horizons and was accepted for a PhD fellowship at the Department of Civil Engineering. Her PhD project considered data and observations from real informal settlement fire events to understand their occurrence holistically.

"Through this analysis, we better understood how the fires started, what influenced fire spread rates, and how inhabitants and firefighters responded," explained Dr Flores-Quiroz. Despite more than 5 000 informal settlement fires reported each year in South Africa, little is known about these topics. Under the supervision of Prof Richard Walls, Dr Flores-Quiroz developed the first framework and approach specifically designed to understand what happens in an informal settlement fire incident. "The value of this framework and approach is that it allows us to develop evidence-based interventions for informal settlement fires," said Prof Walls.

"Through this analysis, we better understood how the fires started, what influenced fire spread rates, and how inhabitants and firefighters responded.

In early 2024, as a postdoctoral researcher, Dr Flores-Quiroz applied her work to one of the world's largest refugee campfires in Cox's Bazaar, Bangladesh. Her contributions to the field are evident in her publication and co-authoring of eight journal papers and her recognition through a Society for Fire Protection Engineering (USA) student grant.

Photo credit: © Justin Sullivan

Fires move very quickly through areas where homes are situated close together. Dr Natalie Flores-Quiroz (insert).

Research **Output**

49	38	2	12	37
Subsidised Journal Articles	International Proceedings	Chapters in Books	Doctorates	Master's Degrees

Research **Themes**

Structural Engineering

We investigate smart and green construction materials, steel and concrete structures, structural reliability, fire engineering, built environment sustainability, and digital construction. Structural reliability covers the probabilistic load and resistance provisions for structural design. Fire engineering investigates structural performance during a fire. Built environment sustainability considers the durability of materials and structures, objective modelling and minimisation of environmental impact. Digital construction develops 3D printing equipment and materials while designing and testing printed structures.

Civil Engineering Informatics

This theme covers the needs of civil engineering practices in an information-driven environment. Applying information technology is concerned with intelligent modelling of the design process, the support systems for engineering management, and the technical aspects of urban engineering. We develop real-time data processing methods for decision-making and modelling complex engineering problems with inherent uncertainties.

Construction Engineering and Management

Research into construction management investigates the management and development of multidisciplinary capital projects. It focuses on modular construction, construction risk, design management, constructability, sustainability and advanced technologies in construction.

Water and Environmental Engineering

Enabling stewardship of our natural resources while developing infrastructure for the functioning of our society is central to modern-day civil engineering. For instance, ensuring reliable and sustainable water supply to human settlements. Water resource development regards environmental requirements when designing large hydraulic structures such as dams, river abstraction works and bridges. A key concern is the medium-term effects of climate change on the continued design suitability of hydraulic and coastal structures.

Geotechnical Engineering

Large and impressive structures invariably require advanced support structures to ensure stability. We work on the challenges of problematic soils and mine tailings. Current research includes robust geotechnical analysis methods, designing high-specification structures on problem soils, and disposal method safety in mine tailings dams.

Pavement Engineering

This group is concerned with designing resilient, sustainable, and long-lasting roads for heavy traffic carried by our world-class network of national highways. Regarding materials science, the group evaluates the performance of secondary materials (crushed concrete, masonry, glass) for roads, accelerated testing of asphalt and environment-friendly bitumen stabilised materials, a performance-related seal design method for bitumen and modified binders, and a mix design and analysis system for asphalt bases.

Transportation Engineering

Road safety and intelligent transport systems (ITS) are top considerations in designing safe and efficient transportation systems. Our road safety research includes road crash causation, human factor influences, the role of geometric design, and public transport and pedestrian safety. Our ITS research covers public transport user information, multimodal database development, appropriate technology applications in developing countries and freeway management information applications for travel-time estimation and incident management systems.

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DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

The Department of Electrical and Electronic Engineering fosters an empowering environment for developing critical thinking and problem-solving skills. Teachers and students collaborate in diverse research groups to advance knowledge of informatics, energy, robotics, telecommunication, and data engineering. Our advanced laboratories and facilities are the perfect playground for inquiring minds to find practical solutions by applying theoretical knowledge. In our Electronic Systems Laboratory, postgraduate students conduct hands-on research on the control and automation of aerospace and terrestrial vehicles, such as the unmanned drone above. This flying workhorse can carry several payloads for different operational tasks.

Prof Herman Engelbrecht (middle) with Prof Deresh Ramjugernath, Deputy Vice-Chancellor: Learning and Teaching and Prof Wikus van Niekerk, Dean of the Faculty of Engineering, after delivering his inaugural lecture.

Building systems for **virtual worlds**

The COVID-19 pandemic has highlighted the importance of developing technology that facilitates communication and working together across long distances. This awareness is particularly pronounced for Prof Herman Engelbrecht, who has chaired the Department of Electrical and Electronic Engineering since 2019 and founded the Data Engineering programme at the Faculty of Engineering.

Prof Engelbrecht has been fascinated by computer games since childhood. He studied electronic engineering at Stellenbosch and flourished in the Department's supportive environment. Fortunately, his academic career coincided with the appearance of massively multiplayer online games (MMOGs), igniting his interest in distributed systems.

Systems for virtual worlds must support millions of users who are simultaneously interacting in the same virtual world. Prof Engelbrecht thrives on building software and systems that distribute the hosting of virtual worlds over multiple servers so that participants can interact seamlessly while unaware of the underlying system.

Building systems that work excites him. When he started researching systems for building MMOGs, he noticed that most ideas were only evaluated on paper or tested using simulation. He decided to conduct applied research verified using a functioning virtual world.

In 2012, Prof Engelbrecht and his students tested their first system using a popular MMOG, Ultima Online. Attracted by its 30 million users, they soon switched to Minecraft. They wrote software modules that integrated and changed Minecraft's fundamental functioning. Currently, they have a single Minecraft virtual world hosted by a server cluster of 120 small, single-board Raspberry Pi computers, enabling players to move around the world blissfully unaware that they are being migrated between servers.

In November 2023, Prof Engelbrecht presented his inaugural lecture titled "Building the Metaverse", which gave an overview of the modern approach to building virtual worlds and the metaverse. He sees the metaverse — the merging of virtual reality and virtual worlds — as the next stage of the journey that began when the first letter was written and sent to another person.

Recently, a prominent MMOG developer became interested in their work. Prof Engelbrecht admitted: "What would excite me the most is to see our work being used in an actual commercial virtual world!"

New chair set to improve power system simulation research

Dr Bernard Bekker, an associate professor at the Department of Electrical and Electronic Engineering, has been awarded the prestigious South African Research Chairs Initiative (SARChI) Chair in Power Systems Simulation by the National Research Foundation. This renewable award ensures annual funding of R1 430 000 over five years.

Prof Bekker believes this chair fits well with the research in the Department's Power Systems research group which is part of the Eskom Power Plant Engineering Institute's Specialisation Centres network. The group studies variable renewable energy generation and customer behaviour on the traditional electrical power system.

The new chair's vision is to leverage the Department's expertise and relationships to develop national competency in power system simulation in South Africa. It will enhance methodologies and input assumptions for simulating aspects of present and future electrical power systems.

Power system research fascinates Prof Bekker because of the rapid changes in technology, communications, data science and market models. South Africa's frequent load shedding demonstrates the dire need for more research on power system planning, with accurate simulations for long-term solutions. He is excited to enhance the Department's current expertise in this research area for the benefit of the whole country.

Women can thrive in Engineering

Being clever, tough and tenacious might not be enough for a woman to become a professional engineer. However, Drs Chantelle van Staden and Karen Garner say having supportive mentors can make a significant difference in navigating male-dominated environments.

Dr Van Staden, a lecturer in the Department, learned the importance of mentoring from her grandparents, who supported her during a difficult time in her teenage years. She worked hard, entered a science project competition in Grade 11, and won a Department of Water Affairs bursary. This scholarship opened up engineering studies at Stellenbosch University (SU).

She sees a mentor as someone who notices your zeal and wants to help you to the next level. Influential mentors like Prof Johan Vermeulen, who supervised her postgraduate studies, and Prof Petrie Meyer, vice-dean for research and industry liaison in the Faculty of Engineering, played pivotal roles in her academic and professional growth.

Dr Garner, a senior lecturer, grew up in Mitchell's Plain on the Cape Flats. Her dream of becoming an engineer started with the broken telephones her dad, who worked for Telkom, brought home for her and her two younger brothers to play with. She convinced him to send her to a technical high school. Dr Garner achieved top marks through hard work and received a bursary from Eskom to study at SU.

She benefited from mentorship during crucial stages of her life. While working at Eskom during the holidays, Leanne Perumal, a successful and groundbreaking female engineer, mentored her. The female secretary at the plant taught her that being in a male-dominated environment doesn't mean you have to act or dress like a man. Your skills and your work will show your ability. Joe Sikhonde, a senior engineer, mentored her in handling difficult clients and plant managers. While studying for a doctorate, her supervisor, Prof Maarten Kamper, offered her a lectureship.

Now, assuming leadership roles, these women are paying it forward. They are mentoring and inspiring young colleagues and students to succeed, helping to create a more inclusive and empowered academic community.

Dr Karen Garner and Dr Chantelle van Standen

South Africa's first **Data Engineering** graduates

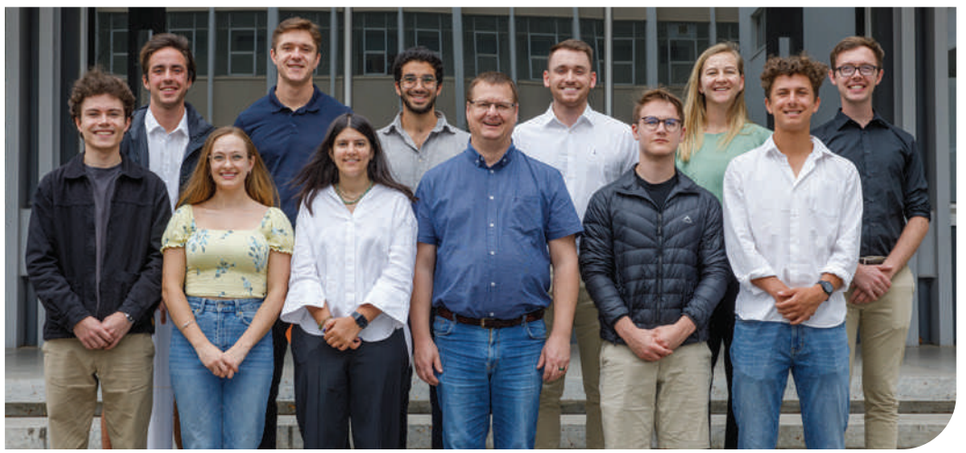
At the Engineering Faculty's highly anticipated December graduation ceremonies, the Department of Electrical and Electronic Engineering celebrated the graduation of its first batch of students specialising in Data Engineering. This rapidly growing field integrates computer science, statistics, artificial intelligence and domain expertise to extract valuable insights from data.

These graduates have completed a rigorous curriculum that introduced new undergraduate modules in Data Engineering, such as Big Data Platforms, Probabilistic Graphical Models for Machine Learning and Fundamentals of Deep Learning and Artificial Intelligence. They can now develop systems to collect or generate data, create algorithms and tools to analyse and model the data to find patterns that indicate trends and develop solutions.

They demonstrated this mastery in their final year of study through a capstone project integrating these knowledge areas. The project requires critical analysis of complex systems and the engineering of innovative solutions for real-world problems with a fundamental societal impact. As the demand for uniquely skilled data engineers continues to rise, their achievement marks an important milestone in data engineering education.

Designed to meet the needs of the Fourth Industrial Revolution, the degree is a specialised focus area of the Electrical and Electronic Engineering undergraduate BEng programme. The programme will prepare engineers for the transforming landscape of the modern workplace and lead to postgraduate programmes in the School for Data Science and Computational Thinking in various fields. Also, as a specialisation in electrical and electronic engineering, programme founder Prof Herman Engelbrecht confirmed that Data Engineering students will be eligible for any postgraduate programmes offered by the Department.

Besides, the challenges these students faced by learning from various sources because of the COVID-19 pandemic led to adaptability, resilience and self-reliance. As part of the first group of students in the programme, they have actively given feedback to help improve the programme, contributing to its ongoing refinement. The BEng degree focus in Data Engineering, accredited by the Engineering Council of South Africa, has seen a growing demand, with just short of 100 applicants accepting conditional offers for the 2024 intake.



Proud graduates of data engineering stand with Prof Herman Engelbrecht (chair, Department of Electrical and Electronic Engineering) (front row, blue shirt). Also in the picture are Theodore van Wyk, Shane Erasmus, Nadav Mazor, Paul Ellis, Lise-Mari Prinsloo and Donald van der Westhuizen (back row, left to right); and Simon Malan, Minette Farrell, Rachel Rawraway, Harry Odendaal and Luke Swart (front row, left to right).

Research **Output**

74	118	18	55
Subsidised Journal Articles	International Proceedings	Doctorates	Master's Degrees

Research **Themes**

Robotics

In the Electronic Systems Laboratory (ESL), research, development and projects concentrate mainly on the control of remote sensing platforms. These platforms include satellites (e.g. CubeSats), manned and unmanned aerial vehicles (UAVs), as well as autonomous underwater vehicles (AUVs) and unmanned ground vehicles. As most of the research is part of a larger system, students gain first-hand experience of the full breadth of the management and technical activities required in complex system development.

Electromagnetics

Current activities focus on the following projects: RF and microwave antennas for communications and radar systems, FEM, FDTD and MoM modelling of antennas and wave propagation in complex electromagnetic environments, development of numerical methods and software for simulation of electromagnetic fields, free-space and near-field measurement techniques, optimising complex antennas and microwave components, the Karoo Array Telescope (KAT) and the Square Kilometre Array (SKA). Other activities involve superconducting elements, nanosensors, electromagnetic compatibility, microwave filters and non-linear circuits. An antenna and microwave laboratory, supported by sophisticated instrumentation and powerful computing facilities, provide the infrastructure for research work.

Electrical Energy

This division covers research on electrical energy in terms of conversion, distribution, control and management, and renewable energy. Specifically, attention is given to multilevel power electronic converters, electrical machine design and drive systems, energy efficiency, and the measurement and management of electrical energy. Renewable energy focuses on photovoltaic solar energy, wind generator systems, system identification and grid integration. Our facilities include world-class laboratories and instrumentation for prototype testing and measurement. The Department has the only high-voltage laboratory in the Western Cape for advanced insulator tests and research.

Telecommunications and Informatics

This division works in a variety of areas that involve the manipulation of information-bearing signals. The work comprises the extraction and embedment of information in the signal (digital signal processing), the transmission of such signals over large distances (telecommunication) and through complex networks (communication networks), and automatic learning and the recognition of the signal content (machine learning and deep learning) with particular focus on speech and image signals, and specialised sensor signals.

Chair

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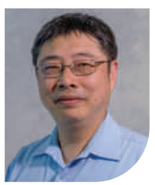
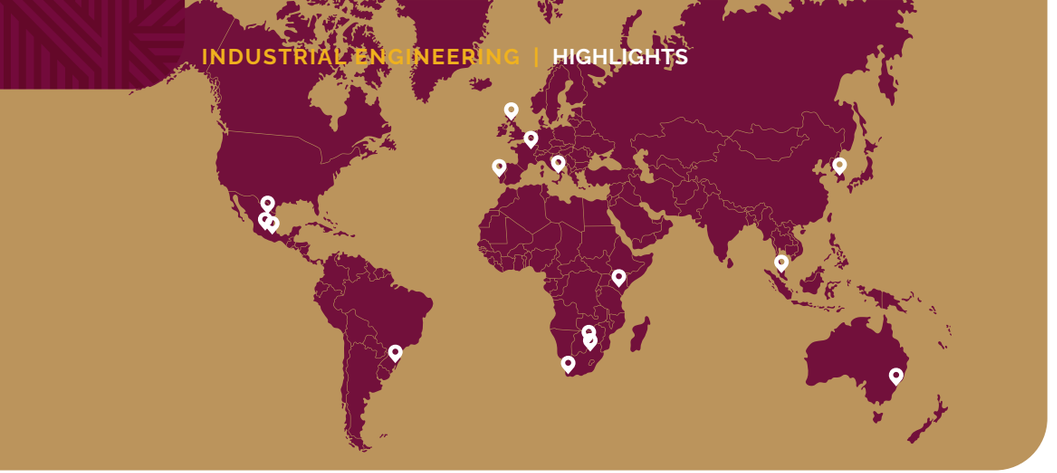


DEPARTMENT OF **INDUSTRIAL ENGINEERING**

The rapid development of technologies enabling new ways of generating, processing and sharing information involving cyber-physical systems has placed us at the dawn of the fourth industrial revolution. The Department of Industrial Engineering produces a new breed of engineers equipped with computational skills and knowledge of the tools to help modern businesses adapt and stay competitive. They can provide solutions by assessing the immediate situation, often by thinking outside the box.



Staff and students disseminate research results **worldwide**

Through international conferences, the Department of Industrial Engineering's academics and their students tapped into a world of knowledge and connection. They shared and discussed recent advances and technological breakthroughs with renowned scholars in similar fields. These fruitful connections pave the way for scientific cooperation worldwide.

Our globetrotters with the most destinations were Profs Andries Engelbrecht and Sara Grobbelaar. As shown by the map above, the Department's international reach in 2023 included:

Australia (Sydney)
Botswana (Palapye)
Brazil (Porto Alegra)
France (Nancy)
Italy (Naples)
Kenya (Nairobi)
Korea (Seoul)
Malaysia (Kuala Lampur)
Mexico (Mexico City, Monterrey, Quértaro)
Portugal (Lisbon)
South Africa (Cape Town, Pretoria)
United Kingdom (Edinburgh)

Popular hybrid postgraduate programme flourishes under **new leadership**

The Department of Industrial Engineering appointed Associate Professor Taryn Bond-Barnard as the academic coordinator for the structured Master of Engineering in Engineering Management (MEM) programme and as the presenter of the Project Management module. In January, she took over the position from Prof Calie Pistorius, the programme's founder. She aims to establish strong relationships with faculty members and the programme's stakeholders.

In 2023, the programme welcomed a second cohort of 104 working professionals seeking to enhance their undergraduate education with additional leadership and management skills. These students registered for the first year of the flexible MEM programme, which combines face-to-face and online learning. Additionally, 67 students registered for the second academic year, with 16 permitted to complete their research assignment module concurrently with their four second-year modules. By the end of 2023, 14 students completed this module, with seven earning distinctions.

Throughout the year, eight virtual Open Day sessions and two networking events (one in Sandton and another in Stellenbosch) offered prospective students the opportunity to gain first-hand insight into the programme. Attendees had the chance to have meaningful discussions and establish fruitful connections by engaging with current MEM students, lecturers and research supervisors.

Prof Taryn Bond-Barnard

Prof Bond-Barnard said her inspiration comes from seeing her students succeed and positively impact the world: "My goal for the MEM programme is to continue producing sought-after engineering leaders who flourish in the new world of work and make substantial contributions to addressing societal challenges."

Professor **ranked first** in computer science in South Africa

Professor Andries Engelbrecht, who holds the Voigt Chair of Data Science, was ranked as the leading expert in Computer Science in South Africa.

Research.com's Best in Computer Science ranking, which considered multiple bibliometric data sources and examined over 27 000 scientists in the field of computer science, placed Professor Engelbrecht with 28 320 citations at the top of the list, decisively ahead of the runner-up, who has 12 575 citations.

The World Online Ranking of Best Computer Scientists places Prof Engelbrecht at number 1 807 on their list.

SAIIE and POMS awards recognise **excellence**

The open-access, peer-reviewed South African Journal of Industrial Engineering (SAJIE) promotes articles on practical applications, original research and meaningful new developments.

The South African Institute of Industrial Engineering's (SAIIE) prestigious Award for Best Industrial Engineering Paper Published in SAJIE went to Ms Jennimi de Waal (née Laubscher) and her supervisor, Prof James Bekker. Ms De Waal completed her MEng (Industrial Engineering) degree with distinction in 2022. Their winning paper, "Base Models for Simulating the South African Forestry Supply Chain", demonstrated that simulation models could perform scenario analysis and bi-objective optimisation in a successful collaboration of industrial engineering and forestry science.

Runner-ups Dr Martin du Plessis (left) and his supervisor, Prof Joubert van Eeden, are standing next to the event chair, Prof Corné Schutte, and Ms Jennimi de Waal, co-winner of SAJIE's best paper award.

Dr Martin du Plessis, a postdoctoral research fellow at the Department of Industrial Engineering, and his supervisor, Prof Joubert van Eeden, secured the runner-up award in the same category. Earlier, Dr Du Plessis won the Production and Operations Management Society's Dino Petrarolo Emerging Economies Doctoral Student Award for demonstrating the most promise as an operations management scholar.

Department staff members assume **new roles**

The Department of Industrial Engineering is proud to announce that two esteemed staff members, Prof Corné Schutte and Prof Joubert van Eeden, will take on new roles in 2024.

Prof Corné Schutte, the Chair of the Department of Industrial Engineering, has been promoted to vice-dean of research and industry liaison. He has a wealth of experience and academic excellence, obtaining BEng, BEngHons, and MEng degrees in industrial engineering with distinction. Prof Schutte's career includes international contributions to projects in France, the UK and the USA. He has been a valuable member of Stellenbosch University since 2005, earning accolades such as Lecturer of the Year in 2017, Research Excellence awards in 2018 and 2021, and the Kris Adendorff Award for Most Prominent Industrial Engineering Professional in 2022.

Prof Joubert van Eeden will assume the role of the department chair. He holds a BEng in Electronic Engineering, MEng, MBA (cum laude), and a PhD in Industrial Engineering, all from Stellenbosch University. Prof Van Eeden specialises in container flow modelling, logistics and supply chain management. With his experience serving as the secretariat for the Sustainable Road Freight Research Group in South Africa and consulting for various companies over the past two decades, Prof Van Eeden is well-equipped to lead the Department.

Senior lecturer's retirement is **the ultimate endgame**

Mr Konrad von Leipzig

After 37 years as a senior lecturer in the Department of Industrial Engineering, Mr Konrad von Leipzig has retired. However, despite yearning to travel, he is still heavily involved in supervising master's students, managing research activities at Reutlingen University and serving on the organising committee for the annual Learning Factory Conference on the upcoming smart factory of the fourth industrial revolution.

Mr Von Leipzig obtained his BEng and BEngHons from Stellenbosch University in 1981 and 1982. To fulfil his bursary obligations, he worked as an engineer at Iscor in Vanderbijlpark for four years. He received a BCom from Unisa in 1990 and a Master of Engineering (Industrial Engineering) from Stellenbosch in 1993.

In 1986, the Department invited him to interview for a lectureship position. Following an unconventional interview at the home of the department chair, Prof Reynecke, where Mr Von Leipzig arrived dressed formally while Prof Reynecke answered the door in casual attire, he was offered the position. He started teaching on 1 January 1987.

Mr Von Leipzig's proficiency in German was advantageous in his role as director of the Institute for Industrial Engineering (Ibi). Working under his role model, Prof Niek du Preez, he forged strong ties with the Fraunhofer Institute, coordinating consulting projects and running a joint laboratory, primarily under the leadership of Prof Dimitri Dimitrov.

A lengthy collaboration with Reutlingen University began with Prof Vera Hummel's involvement in establishing a learning factory in the Department. They initiated an annual staff and student exchange project alternating between Reutlingen and Stellenbosch. This collaboration culminated in a dual research master's programme, a unique offering for German institutions. The programme attracts up to six students annually from each department, providing academic benefits and broadened cultural perspectives.

Mr Von Leipzig co-authored 20 journal articles, presented 49 conference papers, is preparing three more to be delivered in 2024, was (co-)study leader for 125 master's and MBA students and co-supervised four PhD students.

Prof James Bekker, a former student and colleague, has known Mr Von Leipzig for 28 years. He says, "Konrad leaves a notable footprint in the Department. We shall miss his unique sense of humour, often as dry as his beloved Namibia, his friendly bickering and joyful spirit. *Mach's gut, mein Freund!*"

Research **Output**

108	95	3	4	22	79
Subsidised Journal Articles	International Proceedings	National Proceedings	Books	Doctorates	Master's Degrees

Research **Themes**

Engineering Management

Our research aims to improve value creation in technology-based enterprises by focussing on the following:

- *Enterprise Engineering*: Analysing enterprise design, implementation and operation to improve knowledge, innovation, financial and technology management.
- *Sustainable Systems*: Enabling the transition to sustainability by enhancing systems and technology evaluation, development, planning, design and management.
- *Health Systems Engineering*: Finding engineering solutions for challenges facing the healthcare sector.
- *Innovation for Inclusive Development*: Analysing, developing and evaluating inclusive innovations and systems.
- *Industrial Policy and Beneficiation*: Enabling mineral-rich countries to achieve sustainable development.
- *Innovation*: Management of technological innovation, innovation strategy, dynamics of technological change and the impact of emerging technologies..

Manufacturing

Our research covers the development of resource-efficient process chains for the sustainable and smart manufacturing of products through digital, economically-sound process chains that minimise negative environmental impacts while conserving energy and natural resources.

Additive and subtractive manufacturing; reverse engineering, materials design and development; prototyping, ergonomics (human factors); commercial readiness; micro-manufacturing; novel biocompatible alloy development.

Operations Management

Operations and supply chain management focus on process excellence from both intra-organisational and inter-organisational points of view in the following areas:

- *Asset Management*: Improving the coordinated activities of an organisation to realise value from assets.
- *Supply Chain Management*: Leveraging the impact of 4IR technologies to improve operations and supply chains through digitalisation.
- *Sustainable Freight Transport*: Facilitating decarbonisation of freight transport activities by focussing on modal shift and vehicle technology.

Systems Modelling, Operations Research and Decision Support

This theme covers the development of mathematical models and their incorporation into computerised systems to support effective decisions in the industry. These models draw from applied mathematics, statistics, industrial engineering and computer science and apply to complex problems with many trade-off solutions. Examples include routing and scheduling decisions for delivery vehicle fleets, employee duty roster/timetabling construction, optimal production facility layout; simulation; spatio-temporal modelling using machine learning; and sentiment analysis.

Data Science

Research produces novel, efficient and robust data science technologies by developing machine learning and optimisation techniques. Data science techniques are applied to data sets to reveal patterns, trends and associations. Examples include:

- Forecasting customer demand from millions of retail transactions to understand demand patterns.
- Determining optimal segmentation of customers to customise service delivery and develop targeted marketing strategies.
- Using machine learning to predict order delivery times in a distribution scenario.
- Analysing imaging data for real-time inventory decision making.

Fourth Industrial Revolution and the Internet of Things

This theme focuses on automating industry and society using large-scale machine-to-machine communications, sensors, actuators, and other connected devices (the "Internet of Things"). Automatisation enables autonomous interaction between machines and humans. Examples include smart systems in transport and agriculture; intelligent management of energy and water in education and health sectors; real-time digital modelling of devices and industrial processes, using this "digital twin" for monitoring, diagnostics and prediction.

Chair

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DEPARTMENT OF MECHANICAL AND MECHATRONIC ENGINEERING

Instrumental in providing quality engineering education in South Africa since 1944, the Department were the first to offer a degree programme in Mechatronics. This led to our name change to the Department of Mechanical and Mechatronic Engineering in 2006. Our newly refurbished research and teaching environment, including a dedicated Mechatronics Laboratory, provides top-notch facilities where graduates are equipped to tackle modern engineering challenges. In the image above, Mr Raymond Lekholoane, a master's student in Mechatronic Engineering, assists a first-year student in using a milling tool to shape a hammer.

In the left picture, fellow student Fama Fallow presents Ella Gardner's (far right) project to prospective students on Open Day. In the right picture is Gardner's STEM-inspired toy for young South African girls.

A **creative engineering** solution changes the gender narrative

Children learn by playing. What better way to get girls interested in Science, Technology, Engineering and Mathematics (STEM) topics than through play? If only they could find the right toys…

Ella Gardiner, a BEng in Mechatronic Engineering graduate, recognised this gap in the toy market. She dedicated her final-year project, under the supervision of Prof Deborah Blaine, to finding a solution.

"Studies show that parents tend to buy their children gendered toys even when a gender-neutral option is available," says Gardiner. "Typically, male-gendered toys focus on technology and construction, promoting spatial awareness and problem-solving skills, whereas female-gendered toys focus on nurturing and beauty, enforcing maternal roles. Very few engineering toys that target girls are available in South Africa."

Using her engineering skills to change this narrative, Gardiner combined elements from a crystal unicorn terrarium, typically designed for girls, and a solar-powered robotic dinosaur, usually for boys. Her solution was a solar-powered unicorn capable of walking and flapping its wings. The toy comprises separate pieces a child can assemble.

The design incorporates fundamental engineering concepts: a photovoltaic cell harnesses solar power to drive a motor, which then operates a gearbox connected to a crank-and-shaft mechanism.

Gardiner created an accompanying storybook to make the toy accessible for girls in households where parents may not be educated in STEM. Following the story of Aisha, a little girl who dreams of bringing her unicorn to life, girls learn how to assemble the toy. The story explains all the concepts demonstrated in the toy in a user-friendly way.

Projects like these are valuable as they explore the alternative engineering interfaces that one might take time to consider.

Mariner 4.0 **helps seafarers** combat seasickness

Some seafarers are more susceptible to seasickness than others, and the unpleasant symptoms may interfere with their ability to work. Mariner 4.0 has been developed to help seafarers who are susceptible to seasickness. Dr Nicole Taylor, a postdoctoral research fellow in the Sound and Vibration, and Mechatronics, Automation and Design research groups in the Department of Mechanical and Mechatronic Engineering, is the innovator behind this human cyber-physical system.

"Existing models tend to describe levels of motion sickness for groups rather than individuals," says Dr Nicole Taylor, who recently obtained her doctorate in Mechatronic Engineering. Dr Taylor researched motion sickness among passengers and crew on the SA Agulhas II, South Africa's polar supply and research vessel, under the supervision of Profs Annie Bekker and Karel Kruger. Her work was featured in the business technology magazine *Brainstorm*.

Dr Taylor developed the Mariner 4.0 system as part of her doctoral research. The system consists of a user-friendly mobile app and a paper-based questionnaire to collect data on motion sickness in almost real time, a novel feat in shipping. The system helps to monitor and analyse motion sickness in correlation with ship motion, enabling quicker interventions to reduce the severity of symptoms during voyages.

Moreover, using motion sickness's incidence and dose value, Dr Taylor developed guidelines for assessing motion sickness in individuals and groups to determine personalised diagnostic thresholds. These thresholds can be adjusted to different voyage specifications and durations of motion exposure, potentially aiding in voyage planning and ship design.

She says future work includes extending seakeeping analyses to incorporate weather forecasts into voyage planning: "The aim is to predict motion sickness incidence on board to support tactical decision making, including weighing up different voyage routes. The comfort of passengers at sea matters."

Science and engineering merge to strengthen **medical device value chains**

Anne Turner pursued biomedical engineering research, driven by her passion for science and engineering and inspired by her parents, both medical doctors. She obtained her Master of Engineering Science at the Faculty of Engineering's March graduation ceremony.

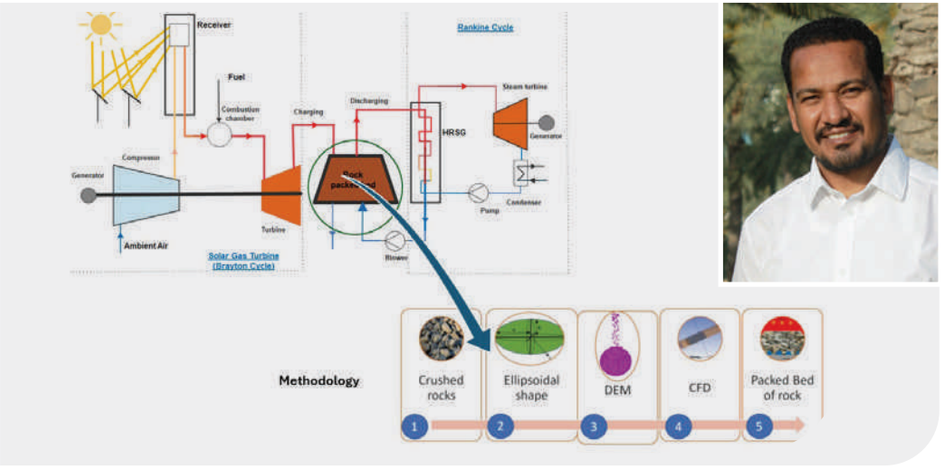
Before this, Turner earned a BSc in Molecular Biology and Biotechnology and a BScHons in Plant Pathology from the Faculty of Science. Her academic journey in the Faculty of Engineering at the Institute for Biomedical Engineering equipped her with specialised knowledge and skills in biomedical engineering technology and research, thanks to the support of her lecturers.

Turner found the transition from a scientific approach to a more independent research methodology in engineering challenging but rewarding. For her master's thesis, *Strengthening the Value Chain of Medical Devices: A Conceptual Framework*, she credits her supervisor, Prof Sara Grobbelaar, for guiding her through the process. Prof Martin Nieuwoudt and Dr Faatiema Salie co-supervised her project.

Through in-depth research, Turner developed a conceptual framework for the medical device value chain to help stakeholders identify bottlenecks in the production process and implement strategic alleviations. The framework outlines 74 value-adding activities, from identifying a need to disposing of the device. It highlights undesirable bottlenecks in the value chain and suggests measures to encourage positive outcomes.

Turner's framework revealed that the main bottlenecks in South Africa's medical device value chain were the lack of a mature regulatory authority, poor collaboration, and insufficient funding and venture capital. She recommended improved networking, funding and regulatory harmonisation as potential solutions to these challenges. Her research will strengthen the Western Cape's medical device sector.

Dr Nicole Taylor aboard the SA Agulhas II.



Dr Elzubeir Hassan (insert) enhanced the design of packed rock bed systems for thermal energy storage using the research methodology depicted in the above diagram.

Doctoral research improves **thermal energy** storage systems

An experienced renewable energy engineer, Dr Elzubeir Hassan, made the rare decision to leave the Sudanese desert for a while and join the Solar Thermal Energy Research Group at the Department of Mechanical and Mechatronic Engineering in Stellenbosch's mountains. After three years of dedicated full-time research in the Department's state-of-the-art facilities, he obtained his PhD at the Faculty of Engineering's graduation ceremony in December. Additionally, he received the Stellenbosch University Best PhD Dissertation for the Use of ANSYS CFD / ANSYS Mechanical Software Award at the celebration to mark the opening of the new Mechanical and Mechatronic Engineering and Industrial Engineering buildings.

Appreciative of the award sponsored by QFINSOFT, Dr Hassan said the capabilities of ANSYS CFD software significantly improved his doctoral research and helped him produce accurate, superior results: "ANSYS CFD effectively simulated the heat flow in a packed bed of solid particles in a thermal energy storage system, which was critical to the accuracy and success of my research findings."

The research presented in his dissertation, *Flow and Heat Transfer in a Packed Bed of Rock*, under the supervision of Prof Jaap Hoffmann, focused on predicting the anisotropic pressure drop through packed beds of crushed rock particles for thermal energy storage at concentrating solar power plants.

The research emphasised the importance of accurately predicting the pressure drop for crushed rock and the need for further investigation into the ideal size and shape of the rock bed. It also highlighted the significance of developing a correlation to capture the flow direction and predict the pressure drop through a packed bed of crushed rock, essential for designing and implementing the bed effectively.

The study's findings contribute to the development of improved models and correlations for designing and implementing packed bed systems in the field of renewable energy.

Dr Hassan thanked his supervisor, colleagues and friends for encouraging, inspiring and supporting him: "This journey has been a remarkable experience of growth, learning and collaboration."

Research **Output**

70	40	7	12	40
Subsidised Journal Articles	International Proceedings	Books	Doctorates	Master's Degrees

Research **Themes**

Energy and the Environment

In close collaboration with the Centre for Renewable and Sustainable Energy Studies, the Department contributes to fundamental research into a wide range of energy generation technologies. Addressing transport needs, the group investigates the performance and impact of biofuels and blends in compression-ignition and spark-ignition engines. Finding uniquely South African solutions for concentrating solar thermal power and energy storage systems, the group's world-leading research in air-cooled heat exchangers and cooling towers is well known. Excellent experimental capabilities and strong computational expertise enable the group to develop custom-made fans, compressors and turbines for ocean current, wind and solar energy exploitation, and air-cooled and hybrid (dry/wet) cooling systems. Research covering the energy-efficient design of ship propulsion, ship hulls and various turbomachinery is supported by the only 90 m long towing tank in southern Africa. The Department boasts the largest fan test facility (7 m diameter) in South Africa.

Mechanics and Dynamics

The group's activities consist of fundamental research on materials, the behaviour of structures and failure mechanisms and criteria. The materials research focuses on powder metal processing and products, material property extraction using digital image and volume correlation, characterisation of granular materials, and qualification of additive manufactured parts. The structures research looks for a fundamental understanding of the behaviour of structures under static and dynamic conditions and, in the case of vehicles, aircraft or ships, their impact on humans. Failure mechanisms and criteria cover composite materials and fracture and creep deformation of steels.

Mechatronics, Automation and Design

Diverse mechatronic systems such as reconfigurable manufacturing systems, machine vision applications, cyber-physical systems and digital twins, augmented/virtual reality and human-system integration. These systems are applied in diverse contexts, including manufacturing, mining, health care, renewable energy systems, motor vehicles production, facilities management and maintenance management

Computational Modelling

The group's expertise in optimisation theory and algorithm development, finite element methods (FEM), computational fluid dynamics (CFD), discrete element methods (DEM) and continuum methods is world-renowned. The DEM work is applied to, among other things, mining and earthmoving equipment, particle dampers and conveyors. We often link optimisation methods with the FEM and CFD work in applications related to fluid-structure interaction, turbomachinery, combustion and various renewable energy technology applications. The group also has expertise in the modelling and simulation of metal casting processes, emphasising solidification analysis and segregation.

Biomedical Engineering

Technologies such as 3D printing, microcomputers and artificial intelligence are opening up new opportunities for engineering in the biomedical field. This group develops innovative minimally invasive devices to collect healthcare information, mechatronic devices for telemedicine, customised solutions for treating specific diseases, and develops and tests medical sensors for in vivo testing of the human knee's biomechanical properties.

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Outreach Programmes

Open Day

The annual online and on-campus Open Day unlocks the fascinating world of engineers and its vast career opportunities for learners, parents and the general public.
Enquiries: Ms Tanya Ficker
+27 21 808 9403 | tanya@sun.ac.za

Women in Engineering

During the annual Women in Engineering afternoon, Grade 10 to 12 girls who excel in Mathematics and Physical Sciences are introduced to the possibilities of a career in engineering. The event features women engineers from various industries, along with lecturers and students, who share their insights and experiences.
Enquiries: Mr August Engelbrecht
+27 21 808 3947 | august@sun.ac.za

Engineering Winter Week

During the annual Winter Week, Grade 11 and 12 learners gain a comprehensive understanding of the engineering profession. This event includes presentations by lecturers and engineers, as well as visits to industries and laboratories, providing students with a clear picture of an engineer's work.
Enquiries: Ms Portia Adonis
+27 21 808 4203 | winterweek@sun.ac.za

Top Achiever Sessions

Top achievers in Grade 11 and 12, along with their parents, are invited to sessions held in Stellenbosch and major cities across South Africa and Namibia. These sessions provide information about engineering careers and the Faculty's degree programmes. Additionally, some departments conduct programme-specific webinars to further promote their engineering degrees and boost registrations.
Enquiries: Mr August Engelbrecht
+27 21 808 3947 | august@sun.ac.za

First Generation Experience

Universities can be pretty daunting if you have no experience in academic or tertiary institutions. In 2018 the Faculty launched this outreach for Grade 11 and 12 top achievers whose parents have not had the opportunity to attend university. During a day visit, they experience the exciting vibe of campus, learn about the Faculty's degree programmes and other SET fields of study and meet the Dean.
Enquiries: Mr August Engelbrecht
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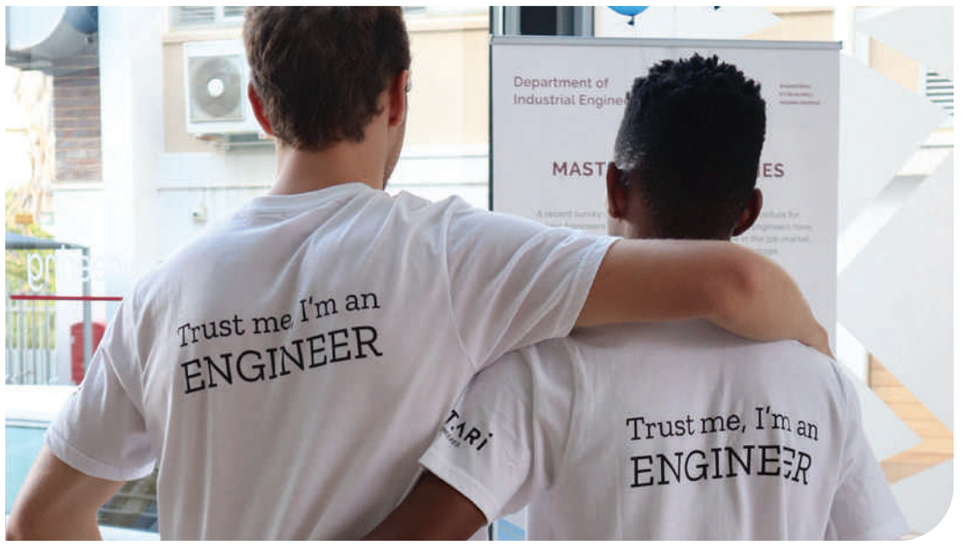

Mr August Engelbrecht enthusiastically explains to primary school learners what it takes to become an engineer during a visit to the Department of Civil Engineering. Mr Engelbrecht is our student recruiter and Faculty representative for the Division of Social Impact at Stellenbosch University.

Talent Development Programme

The Department of Science and Innovation, in collaboration with the Department of Education and SUNCEP at Stellenbosch University, initiated this school holiday enrichment programme. Offered in all nine provinces, Grade 11 and 12 learners (mostly black) are brought together and instructed by the best Mathematics and Physical Sciences teachers in their respective provinces. Our Faculty visits these centres for recruitment.
Enquiries: Mr August Engelbrecht
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An outreach to increase the registration rate of black, African speaking students in South Africa

In October 2019, we launched an outreach project aimed at increasing the registration rates of black, African-speaking students in South Africa. The initiative targeted prospective students from nine vernacular language backgrounds (excluding English and Afrikaans) who received provisional offers to study engineering at Stellenbosch University. Senior Matie students from similar language backgrounds participated in the project, addressing the prospective students in their mother tongue. They shared their experiences as engineering students at Stellenbosch University and helped alleviate any fears and concerns.
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TRAC South Africa

TRAC, a community intervention programme of Stellenbosch University, offers support in Mathematics and Physical Sciences to Grade 11 and 12 learners from disadvantaged and poor communities across South Africa. TRAC also provides vocational guidance to its beneficiaries, assisting them in applying to tertiary institutions and facilitating the process of funding applications for tertiary studies.
Enquiries: Ms Debbey Olivier, debbey@sun.ac.za

Top and middle right: Primary school learners enjoying an outreach co-funded by Railway Safety Regulators and Gibela.
Middle left: A senior Matie student is encouraging black students to register by addressing their concerns in their mother tongue.
Bottom: Enthusiastic Grade 10 to 12 girls attending the annual Women in Engineering event.

The entrance to the newly renovated Civil Engineering building.

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