



ANNUAL REPORT Faculty of Engineering

2017

Fakulteit Ingenieurswese
JAARVERSLAG



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ENGINEERING
EZOBUNJINELI
INGENIEURSWESE

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Overview



Our recruiter, August Engelbrecht (back, far left), with the 12 students who conducted a telethon to tell Grade 12s about their positive experience as current Maties engineering students.

The Faculty of Engineering is one of Stellenbosch University's flagship faculties. The world-class engineers we produce contribute to the economic development of the country and improve the quality of life for all citizens. In addition, our outstanding research and consulting services add value to industry and supplement our primary funding streams.

Sustaining our momentum of excellence

Our reputation as a faculty of choice again secured a large first-year intake in 2017. Testifying to the calibre of students we attract, the dedication of our teaching staff, and the quality of our programmes, our undergraduate pass-rate of 86% broke through the 85% ceiling for the first time since 2011. And for the second consecutive year, our student body included the Chancellor's medal recipient: Jacqueline Kazmaier. Ms Kazmaier achieved an average of 89,7% over her four-year BEng (Industrial Engineering) studies, with distinctions for all her modules. She is the fourth female engineering student to win this coveted award since 2003, and we are very proud of her!

At postgraduate level, our research activities continue to strengthen, with the number of postgraduate students tripling over the past decade. We are particularly proud of the increase in our number of PhD students, from nine students in 2006 to 43 in 2017. This has resulted in a significant increase in our number of publications, with our weighted research output per academic being the second highest at Stellenbosch University. Further, an independent study found that our students complete their master's and doctoral degrees in the shortest average time of all engineering

faculties in South Africa – a noteworthy achievement to add to our teaching-and-learning record.

Staff excellence was highlighted when two of our academics, Profs James Bekker and Jan van Vuuren, were honoured by the Southern African Institute for Industrial Engineering, awarding their contributions to industrial engineering in the region, and Prof Maarten Kamper, Chair of Electrical and Electronic Engineering, receiving a Chancellor's Award for excellence from the University. Our academic staff receiving National Research Foundation ratings increased by another six, to total 43.

Ensuring sustained excellence, the University Council approved the R723 million needed for our Engineering campus upgrade. This extensive project includes a complete refurbishment, upgrade and densification of our 50-year-old facilities, enabling us to accommodate even more students and staff in a modern teaching, working and laboratory environment. In addition, our strong ties with industry have secured us third-stream income of ±R150 million per annum, which matches our allocation from the University's main budget and is vital to ensure our financial sustainability.

Broadening access

We draw our new students from a fairly small pool of Grade 12 learners who achieve distinctions in Mathematics and Physical Sciences. As competition to attract the best students is fierce, we have appointed a dedicated student recruiter to carry out a comprehensive recruitment plan. This includes attracting top-performing black African, coloured, Indian and Asian students to increase the diversity of our student body. Recruitment initiatives included a

Die Fakulteit Ingenieurswese is een van die Universiteit Stellenbosch se vlagskipfakulteite. Die wêreldklasingenieurs wat ons oplei, dra tot die ekonomiese ontwikkeling van die land en 'n beter lewensgehalte vir inwoners by. Ons uitmuntende navorsing en konsultasiedienste voeg boonop waarde toe tot die bedryf en vul ons finansieringstrome aansienlik aan.

Behoud van ons uitnemendheid

Ons goeie reputasie as 'n fakulteit van keuse het ons in 2017 weer 'n groot eerstejaarinname besorg. Ons voorgaande slaagsyfer van 86% het vir die eerste keer sedert 2011 die 85%-merk verbygesteek. Dit dui op die kaliber studente wat ons lok, die toewyding van ons onderrigpersoneel, en die gehalte van ons programme. Ons studentekorps het vir die tweede jaar in 'n ry ook die Kanseliersmedaljewenner opgelewer. Jacqueline Kazmaier het 'n gemiddeld van 89,7% oor haar vier studiejaar in die program BIng (Bedryfsingenieurswese) behaal, en onderskeidings deur die bank. Sy is die vierde vroue-ingenieurstudent sedert 2003 wat hierdie gesogte toekenning wen.

Op nagraadse vlak gaan ons navorsingsbedrywighede steeds van krag tot krag. Ons getal nagraadse studente het die afgelope dekade verdrievoudig. Ons is veral trots op die toename in ons getal PhD's van nege in 2006 tot 43 in die verslagjaar. Daarmee saam het ons publikasies ewe beduidend toegeneem, en het ons die tweede hoogste geweege navorsingsuitset per akademikus by die Universiteit. 'n Onafhanklike studie het ook bevind dat ons studente hul magister- en doktorsgrade binne die kortste gemiddelde tyd van alle ingenieursfakulteite in Suid-Afrika voltooi – 'n merkwaardige prestasie om by ons onderrig-en-leerrekord in te sluit.

Wat personeeluitnemendheid betref, is twee van ons akademici, proff James Bekker en Jan van Vuuren, met toekennings van die Suider-Afrikaanse Instituut vir Bedryfsingenieurswese vereer ter erkenning van hul bydraes tot bedryfsingenieurswese in die streek. Prof Maarten Kamper, voorsitter van Elektriese en Elektroniese Ingenieurswese, het 'n Kanselierstoekenning vir uitnemendheid ontvang, terwyl ons akademiese kohort met graderings van die Nasionale Navorsingstigting met 'n verdere ses aangegroei het tot 43.

Om volgehoue uitnemendheid te ondersteun, het die US-Raad die begroting van R723 miljoen vir die opknapping van ons Ingenieurswese-kampus goedgekeur. Hierdie omvattende projek bestaan uit 'n algehele vernuwing, opknapping en verdigting van ons 50 jaar oue fasiliteite om vir meer studente en personeellede in moderne onderrig-, werks- en laboratoriumomgewings voorsiening te maak. Voorts verseker ons sterk bande met die bedryf ons van 'n derdegeldstroominkomste van ongeveer R150 miljoen per jaar, wat ons toekenning uit die Universiteit se hoofbegroting ewenaar en noodsaaklik is om finansiële volhoubaarheid te bly.

Verbreding van toegang

Ons studente kom uit 'n betreklik klein groep, naamlik Matriektoppresteerders met onderskeidings in Wiskunde en Fisiese Wetenskappe. In die lig van die strawwe mededinging om die beste studente te werf, het ons 'n toegewyde studentewerwer aangestel om 'n omvangryke werwingsplan uit te voer. Dit sluit ook werwing van toppresterders uit die bruin-, swart Afrikaan-, Indiër- en Asiërgemeenskappe in om diversiteit sodoende 'n hupstoot te gee.

Twaalf van ons bestaande studente het byvoorbeeld in 2017 meer as 100 voornemende swart ingenieurstudente gebel om hulle in hul moedertaal van die positiewe ervaring as 'n Matie-ingenieurstudent te vertel. Om kontinuïteit en



Jacqueline Kazmaier, winner 2017 Chancellor's Medal.
Jacqueline Kazmaier, 2017 Kanseliersmedaljewenner.

successful Engineering Winter Week, career exhibitions, school visits, following up on incomplete applications, and strengthening ties with bursary companies.

A personalised marketing drive in 2017 included 12 of our existing students phoning over 100 prospective black engineering students and, in their mother tongue, sharing their positive experiences as a Maties engineering student. To ensure sustained support, these 12 students will serve as “buddies” to these recruits in their first year of study, assisting them as they integrate into the Faculty.

As we work to create a more welcoming environment for all, we established a Faculty Transformation Committee, with representatives from all five engineering departments, to suggest suitable actions and projects that will provide a welcoming environment for staff and students from diverse backgrounds. We will be expanding this concept to create similar committees within each department. On a practical level, we opened a new, modern and spacious cafeteria that is more accessible and user-friendly. *The Chalkboard* is run by a professional catering company and serves as a new central social meeting place for our growing student body.

Enhancing our social impact

By its very nature, engineering research can offer a direct and positive impact on society. In 2017, we continued to engage with industry, solving problems for the benefit of the broader community. Some exciting new projects include a hand-held nano-electric biosensor using only one drop of blood to enable cancer diagnosis more rapidly and at a lower cost than current methods, cutting-edge tracking systems to combat rhino poaching, value-add

functionality to agricultural products and waste tyres, and research on preventing fires in informal settlements.

We are also fast establishing a reputation for our work in conserving natural resources. A prime example is the Smart Water Meter designed by Prof Thinus Booysen, his team from the Department of Electrical and Electronic Engineering, and a University spinoff, Bridgiot (Bridge to the Internet of Things). This novel meter, called Dropula, provides consumers with detailed information on their daily water use with the explicit intention of changing user behaviour. Piloting the Smart Water Meter at Stellenbosch Primary School, the device reduced the school’s daily water consumption by nearly 70%. On hearing of this success on Cape Talk Radio, the retail giant Shoprite sponsored another pilot site at the Hector Peterson Secondary School in Wallecedene, where water consumption also showed a staggering drop. In November 2017, the #SmartWaterMeterChallenge was launched in partnership with Shoprite, Cape Talk, Bridgiot, Pragma, and later the Western Cape Education Department. Corporates were invited to sponsor a school for two stages of intervention: firstly, for essential maintenance on the existing plumbing to be completed, and secondly, for behavioural change intervention. In total, 93 corporates sponsored 358 schools.

Looking ahead

With new Dean Prof Wikus van Niekerk at the helm, the Faculty is due for its five-yearly Engineering Council of South Africa (ECSA) accreditation visit in 2018, and also plans to grow its doctoral and postdoctoral student corps. To this end, we will identify multidisciplinary flagship projects or research areas that tie in with the

work of international research groups. In addition, we will be strengthening ties with industry to ensure that we remain relevant in our teaching and research, while also opening up additional income streams.

Wendy Horne, principal of Protea Heights Academy (far right), and her learners who attended the Women in Engineering afternoon.



volgehoue steun te verseker, sal hierdie 12 studente aanstaande jaar ook as "makkers" vir hul rekrute dien, 'n oog oor hulle hou en hulle help inskakel. Ander werwingsinisiatiewe het ingesluit 'n suksesvolle Ingenieurswinterweek, loopbaanuitstallings, skoolbesoeke, veldtogte om onvolledige aansoeke op te volg, en die versterking van bande met beursmaatskappye.

Ons hou aan werk om 'n meer verwelkomende omgewing vir almal te skep. In hierdie verband het ons 'n Fakulteitstransformasiekomitee tot stand gebring, wat uit verteenwoordigers van al vyf ons departemente bestaan. Soortgelyke komitees sal in elke departement saamgestel word om die bestuur oor gepaste aksies en projekte te adviseer om 'n verwelkomende omgewing vir personeellede en studente uit diverse agtergronde te handhaaf.

Om op 'n meer alledaagse vlak 'n toeganklike, gebruikersvriendelike omgewing te skep, het ons ook 'n nuwe, moderne en ruim kafeteria geopen wat deur 'n professionele spyseniersmaatskappy bedryf word. *The Chalkboard* dien as 'n nuwe sentrale bymekaarkomplek vir ons groeiende studentekorps.

Bevordering van ons sosiale impak

Weens die aard van ons navorsing het dit 'n direkte positiewe impak op die samelewing. Ons het in 2017 voortgegaan om met die bedryf te skakel en sodoende probleme tot voordeel van die groter gemeenskap op te los. 'n Paar opwindende nuwe projekte sluit in 'n nano-elektriese biosensor-handtoestel wat 'n enkele druppel bloed gebruik om kanker vroeër en goedkoper op te spoor, hipertegnologiese opsporingstelsels om renosterstropere te bekamp, waardetoevoeging tot landbouprodukte en afvalbuitebande, en navorsing oor brande in informele nedersettings.

Ons maak ook al hoe meer naam met ons werk om natuurlike hulpbronne te bewaar. 'n Goeie voorbeeld is die slimwatermeter wat prof Thinus Booysen, sy span van Elektriese en Elektroniese Ingenieurswese, en 'n afwentelmaatskappy van die Universiteit, Bridgiot ("Bridge to the Internet of Things"), ontwerp het. Dié nuwe meter, wat Dropula gedoop is, bied verbruikers volledige inligting oor hul daaglikse watergebruik met die uitdruklike doel om gebruikersgedrag te verander. In 'n proef by Laerskool Stellenbosch het die slimwatermeter die skool se daaglikse waterververbruik met byna 70% verminder. Nadat hulle op die radiostasie Cape Talk van die suksesse by die eerste

skool gehoor het, het die kleinhandel-reus Shoprite die tegnologie by die Sekondêre Skool Hector Peterson in Wallacedene op die proef gestel, waar verbruik ook drasties gedaal het. Die #SmartWaterMeterChallenge is in November in vennootskap met Shoprite, Cape Talk, Bridgiot, Pragma en later ook die Wes-Kaapse Onderwysdepartement van stapel gestuur. Maatskappye kon 'n skool vir twee fases van die intervensie borg, naamlik instandhouding van loodgieterswerk, gevolg deur gedragsverandering. Altesaam 93 maatskappye het 358 skole geborg.

Vooruitskouing

Met die nuwe dekaan, prof Wikus van Niekerk, aan die stuur verwag die Fakulteit in 2018 sy vyfjaarlikse akkreditasiebesoek van die Ingenieursraad van Suid-Afrika (ECSA), en beplan voorts om sy doktorale en nadoktorale studentekorps te vergroot. Ons sal ook verdere bande met die bedryf smee om relevant te bly in ons onderrig en navorsing, en terselfdertyd bykomende geldstrome te ontsluit. Hiervoor sal ons multidissiplinêre vlagskipprojekte of -navorsingsgebiede identifiseer wat by die werk van internasionale navorsingsgroepe aansluit.



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Dekaan: Ingenieurswese.

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Civil Engineering



Creating an interest in Engineering at an early age: At the SU Open Day, Elaine Goosen (PhD student and part-time lecturer in Civil Engineering) explains to a budding young "engineer" the complex change in viscosity that occurs in bitumen, a non-Newtonian fluid.

3 Highlights



Prof Marion Sinclair (right) with PhD student Pascal Nteziyaremye and master's student Saajidah Williams. In the background is the live feed from the SANRAL Traffic Management Centre based in Goodwood, Cape Town.

Road safety expert enjoys wide recognition

Expertise in the field of transportation within the Department of Civil Engineering enjoys recognition locally, nationally and internationally. The result is that academics in the Department are often consulted and invited to serve on advisory bodies. One example is Prof Marion Sinclair, a road safety expert. She is the only academic in South Africa to be involved in all three of the following: the development of the National Road Safety Strategy 2020–2030 (approved by Cabinet in May 2017), the drafting of the Western Cape Road Safety Implementation Plan (2017) and also as a member of the Minister of Transport's National Road Safety Advisory Council (2015 to present).

In 2014 the Department appointed Prof Sinclair as its first female Associate Professor. She says: "Stellenbosch University is the only university in the country that offers road safety as a specialism under transport engineering. We teach road safety at undergraduate and postgraduate levels and research is carried out within South Africa and also across the continent."

One of the key lessons the programme teaches is that even a road designed to the highest international

standards can be unsafe, because road designers seldom take into account how road users can, and do fail. Prof Sinclair notes: "We see that road users often make mistakes because the environment allows them to, or somehow unintentionally confuses them. South Africa has a really abysmal history in road safety, and we are not yet – as a country – working effectively to reduce road deaths. That said, the Western Cape Government has been involved in some excellent interventions, and the National Government itself is beginning to work more effectively towards solutions." She says that it has been a real privilege to be involved in road safety planning for the country. "Road safety is a hugely important field to be working in right now and while there are still tough challenges, it is one field in which it is possible to make significant differences in the lives of South Africans."

Young engineer makes his mark

An alumnus of this Department, Pierre van der Spuy, is the SAICE Young Civil Engineer for 2017. Mr Van der Spuy is a senior structural engineer at Aurecon and has ten year's industry experience. He specialises in bridge analysis and design and is now one of the leading designers of wind turbine foundations in the country.

He won this prestigious award for his work on complex bridge designs including incrementally launched bridges, precast segmental balanced cantilever bridges, long span arch bridges as well as work on wind turbine foundations.

“This achievement demonstrates Pierre’s outstanding ability to help create the best solutions for Aurecon’s clients, by applying a curious mind and an innovative mind-set,” says Ferdi Nell, MD of Aurecon in Africa. Since joining Aurecon, Mr Van der Spuy has worked on projects across Africa, in the United Arab Emirates and in Australia.

In 2017 he took sabbatical from his position at Aurecon to study full-time towards a PhD at Stellenbosch University and was appointed part-time as Adjunct Senior Lecturer in the Department of Civil Engineering for 2017 and 2018 to present the module Advanced Design (Structures).

He showed great potential as an engineering student. In his final year, he was joint-winner of the ECSA Medal of Merit awarded to the top achieving Maties engineering student. He also impressed his lecturers enormously as can be seen from the comment by Prof Gideon van Zijl, Division Head, Structural Engineering and Informatics: “Pierre van der Spuy is one of the top students in civil engineering I have come across during my academic career since 1992.”

Research Output	
Journal Articles (subsidised)	28
Proceedings International	36
Proceedings National	4
Chapters in Books	7
Doctoral completed	6
Master’s completed	59

First graduands to take oath

“I am an engineering practitioner and in my profession I take deep pride. To it I owe solemn obligation.”

These are the opening words of an oath that the Civil Engineering Class of 2017 took on 6 December, the day before their graduation.

Prof Kobus du Plessis, Chair of the Department at the time says: “The idea of such an oath in the form of a Credo for the African Engineering Practitioner originally comes from a suggestion by the South African Institution of Civil Engineering. I supported this

suggestion as I feel civil engineers, in particular, are in the service of communities. In the current climate in our country it is appropriate to highlight the civil engineer’s responsibility towards communities.”

The Credo continues:

*I pledge to practise integrity and fair dealing, tolerance and respect,
and to uphold devotion to the standards and dignity of my profession,
conscious always that my skill carries with it the obligation to serve the public good,
by making the most sustainable use of Earth’s precious resources.
I shall participate in none but honest enterprises.
When needed, my skill and knowledge shall be given without reservation.
In the performance of duty and in fidelity to my profession, I shall give the utmost.*

Prof Du Plessis elaborates: “I tested the idea amongst the final-year class beforehand and the response was extremely positive. It was very touching to see the group stating their commitment out loudly in front of their class mates, parents and lecturers.”

Graduands received a copy of the Credo signed by themselves and the Chairperson to display in their offices as a reminder of the commitment they made to their profession and communities.



Prof Jan Wium
Chair: Civil Engineering.

Water resources development



In the Hydraulic Laboratory: Prof Gerrit Basson (third from the left) explains the hydraulic model tests of the Mhlathuze weir at Richards Bay to the client, Mhlathuze Water, during 2018.

Over the years, the Department of Civil Engineering has made a significant contribution to the design of large hydraulic structures such as dams and water resources development in Africa. Central to this research is the impressive Hydraulic Laboratory that has been in operation for nearly 50 years and is the largest river hydraulic laboratory in South Africa with a floor space of 4 500 m². This laboratory and the expertise of Prof Gerrit Basson (a former Vice-President of the International Commission of Large Dams) and colleagues have been involved in the design of many dams in Africa.

Since 2010 projects have been carried out for six new dams in South Africa, such as the proposed Vioolsdrift Dam on the Lower Orange River. In that period, the team has been involved in the design of twelve dams in African countries, namely in Lesotho, Mozambique, Zimbabwe, Swaziland, the Democratic Republic of the Congo, Nigeria and Namibia. Many of these dams have been constructed or are under construction.

During 2010 the project team was also involved in the Western Cape System Future Planning Study which identified the Voëlvelei Dam augmentation scheme from the Berg River as next priority for the City of Cape Town (the detail design phase to commence in 2018).

The laboratory also plays a major role in the design of sustainable river abstraction works for potable water use and for irrigation. A total of 21 abstraction works has been designed since 2010. Most of these are located in South Africa and the most recent 110 ML/d abstraction works was constructed on the Thukela River in KwaZulu-Natal by Umgeni Water at a cost of R370 million.

Abstraction designs have also been carried out such as in Mozambique, Sierra Leone and Malaysia. Two sea water intakes were designed in Malaysia for cooling of coal-fired power stations, with design pump discharge of 160 m³/s (about 20 times the peak water requirement of the City of Cape Town during summer).

The Department's specialists are also involved in river and estuary restoration projects. One such major project was the iSimangaliso St Lucia Lake and Estuary which was rehabilitated following detailed hydrodynamic modelling of the flow patterns, water quality and sediment dynamics in the estuary and lake (2015). For 60-odd years, dredge spoil was artificially deposited in the natural course of the uMfolozi River by then conservation managers as it was thought that silt exacerbated from the canalisation of the uMfolozi River was the biggest man-induced risk to the 350 km² estuarine system. While sediment is an issue, the modelling identified that the critical issue is fresh water and the uMfolozi River's ability to act as the powerhouse that drives the natural process of the mouth. With support from the Global Environmental Facility and World Bank, iSimangaliso initiated a R65 million Lake St Lucia restoration project (2017).

The health of iSimangaliso's Lake St Lucia ecosystem is critical for some 80 000 people who use it extensively as part of their livelihood strategies. Tourism related directly to the Lake employs an estimated 8 000 people locally. Income from iSimangaliso's 510 000 visitors, 42% of whom are international, contributes some 7% to KZN Tourism GDP. The contribution to fisheries of the Lake St Lucia system is also significant locally, nationally and for Mozambique.

Structural Engineering

Research is carried out on construction materials, steel and concrete structures, structural reliability, bridge engineering, the application of civil engineering informatics in general and steel structures in particular, as well as sustainability of the built environment. Research in fire engineering includes computational investigation of structural performance in a fire, physical investigation of fire behaviour, monitoring of temperatures generated and structural performance. A new research field is the sustainability of the built environment including durability of materials and structures, objective modelling and subsequent minimisation of environmental impact.

Civil Engineering Informatics

Civil Engineering Informatics focuses on the needs of the civil engineering practice in an information-driven environment. Application of Information Technology in civil engineering is concerned with collaborative engineering, intelligent modelling of the design process in structural engineering, support systems for engineering management and technical aspects of urban engineering.

Water and Environmental Engineering

Research fields include water resources development, flood hydrology, environmental water requirements, the design of large hydraulic structures such as dams higher than 100 m, river abstraction works and bridges, river hydraulics, sediment yield and fluvial morphology of rivers, reservoir sedimentation, coastal engineering, port engineering, hydrodynamic modelling of river, lake and estuary flow patterns and water quality, water and wastewater treatment, stormwater systems and water services which include bulk water supply, water demand and water conservation, end-use modelling, alternative water sources, peak flows, stormwater quality, small-scale water treatment systems, hydraulic modelling of water systems, system pressure, pressure management, leaks and intermittent supply.

Transportation and Geotechnics

Research is carried out on road safety and Intelligent Transport Systems (ITS). Road safety research includes road crash causation, the influence of human factors, the role of geometric design, speed, public transport safety, and pedestrian safety factors. Research in ITS focuses on public transport user information, multimodal data base development, appropriate technology applications in developing countries and freeway management information applications for travel time estimation and incident management systems. Student-orientated research in pavement engineering includes accelerated testing of asphalt including MMLS testing and beam fatigue tests, environment-friendly bitumen stabilised materials researched using triaxial and fatigue tests, development of a performance-related seal design method for bitumen and modified binders, and a mix design and analysis system of asphalt bases.

Geotechnics focuses on the upper quaternary sands of the Cape Flats and its engineering geological characterisation in terms of its compressibility, shear strength, hydraulic conductivity and volumetric behaviour during shear (liquefaction potential). Ongoing geological investigations at Matjiesfontein are also carried out in support of the construction of the Space Geodesy Observatory.

Construction Engineering and Management

The focus is on the management and development of multidisciplinary capital projects. It includes an investigation into the skills needed to initiate and manage such projects as well as ways in which these skills can be transferred and developed. The division investigates the use of prefabricated elements and modular construction as well as the way in which it can be used together with in situ concrete to accelerate delivery. Developments in advanced technologies in construction are also investigated.

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Electrical and Electronic Engineering



In 2017 Stellenbosch University received one of its largest individual donations ever – a bequest of R194,6 million by the late Mr DW Ackermann, an engineer by profession. The DW Ackermann Bursary Fund was established to benefit students in Electrical and Electronic Engineering. On the photo are four of the five first recipients of this bursary. From the left are Prof Maarten Kamper (Chair, Electrical and Electronic Engineering), Daniel Banks, Sharmin Khan, Prof Wikus van Niekerk (Dean), Elsje Pieterse and Sihle Tabete.

3 Highlights



Prof Sampson Mamphweli (Director, CRSES) and Dr Bernard Bekker (Eskom Chair in Power System Simulation and Associate Director, CRSES).

Energy expertise augmented

In 2017 the Eskom Chair in Power System Simulation was established in the Department of Electrical and Electronic Engineering, with Dr Bernard Bekker as incumbent. The Chair coordinates research collaboration between Eskom and academia in this critical area given the changing energy landscape.

Within the Eskom Power Plant Engineering Institute (EPPEI) programme, Dr Bekker also coordinates research between Eskom and its academic partners in the fields of power system simulation and renewable energy. These academic partners are Stellenbosch University, the University of Cape Town, Cape Peninsula University of Technology, Tshwane University of Technology and Central University of Technology, with some 50 postgraduate students involved in the two above-mentioned research fields.

Dr Bekker has a third responsibility, that as Associate Director, Centre for Renewable and Sustainable Energy Studies (CRSES) which resorts under the SU Faculty of Engineering. This Centre, which was established in 2006, acts as a central point of entry into Stellenbosch University for the general field of renewable energy. In

2017 Prof Sampson Mamphweli took over the reins as Director, when Prof Wikus van Niekerk, CRSES Director since its inception, became the Dean of Engineering at Stellenbosch University in July.

Prof Mamphweli says: "One of my tasks will be to align the Centre with national policies. The Centre will also be able to assist government with service delivery issues including grand challenges as identified by the Department of Science and Technology, especially in the field of energy. The Centre is well positioned to do so as a result of its research."

Expertise in nanosatellites widely recognised

A nanosatellite, developed by the Department's Electronic Systems Laboratory (ESL) and CubeSpace, was released into space from the International Space Station on 18 May 2017 with 49 other nanosatellites.

The South African nanosatellite, ZA-AeroSat, weighing in at only 2 kg, was the only satellite from Africa as part of an international project (QB50) to launch 50 nanosatellites (CubeSats) to gather measurements from the lower thermosphere between 200 km and 400 km above Earth.

This project formed part of the atmospheric modelling research carried out by the European Space Agency to predict the results of space objects penetrating the earth's atmosphere more accurately.

"Since the ESL and, more recently, CubeSpace (an InnovUS incubation company in the Nedbank SU LaunchLab business incubator) are widely recognised internationally for innovative small-satellite orientation control systems, they were asked to supply 15 control units to other satellites in the QB50 project," says Prof Herman Steyn, Head of the project and founder of CubeSpace. The Cape Peninsula University of Technology (CPUT) was involved in the development of the satellite's communication modules.

"After initial communication difficulties, the ground station at the Department of Electrical and Electronic Engineering eventually managed to confirm that the satellite is partially operational. Only two of the four feather antennas on the satellite deployed, making communication to the satellite only possible during close passes to the ground station. We have already managed to control the satellite into a stable spinning attitude and we are still hopeful to bring it to full operational status in future," Prof Steyn concludes.

Research that benefits ordinary people

In support of Stellenbosch University's aim to become a major role player in Africa, the Department of Electrical and Electronic Engineering joined forces with Pulse Lab Kampala, one of three hubs of the United Nations (UN) Global Pulse programme. This joint research project aimed to develop a prototype tool with which to analyse the content of public radio broadcasts in Uganda to reveal a detailed and current picture of the priorities and concerns of rural Ugandans. The project's ultimate aim is to serve as an early warning system that informs and aids humanitarian and disaster relief efforts by the UN.

Computer speech recognition researchers, Prof Thomas Niesler and his two postdoctoral fellows, Dr Raghav Menon and Dr Armin Saeb, developed software that uses speech-to-text technology to convert recorded speech into text for Ugandan English, Luganda and Acholi. For the two indigenous languages Luganda and Acholi, no such speech recognition technology was available before.

To develop the automatic speech recognition technology for application to radio content, audio files

were transcribed manually to provide contextually relevant examples of radio conversations. A pronunciation dictionary, which indicates the most common sequences of sounds used to pronounce each word, was compiled. The transcriptions and the dictionary represented the basis for a multilingual acoustic model of all sounds in each of

the three languages. Finally, a language model, which estimates of how likely each word is to be spoken in sequence, was developed.

After speech-to-text processing, techniques used in Big Data analytics are applied to achieve automated search whereby the radio content is screened for certain keywords and topics, for example floods, epidemics or cholera. The collaborative research programme with the United Nations has thus provided a technological tool with which such radio discussions can be automatically monitored to obtain information that is used to inform targeted UN relief and development programmes.

"It is very satisfying to be involved in a research project that actually makes a difference in the lives of ordinary people," says Prof Niesler. He and his team are constantly improving and refining their system to make it more flexible, accurate and effective.

Research Output	
Journal Articles (Subsidised)	28
Proceedings International	76
Proceedings National	28
Chapters in Books	1
Doctoral completed	8
Master's completed	47



Smart plan saves millions of litres and rands



Saving water – saving money! Looking at the novel water meter, Dropula, are from the left Mike Mavovana (Principal: Hector Petersen Secondary School in Wallacedene), Debbie Schäfer (Provincial Minister of Education, Western Cape Government), Lumka Schoeman (Shoprite CSI), Cheroline Ripunda (SU master's student and part of the Brigiot team) and learners.

www.schoolswater.co.za
youtu.be/J-zvG0mjQp4

Before this extreme drought the past few years, very few of Cape Town's residents realised how intrinsically her citizens are coupled through the scarce life-giving resource that is water. A few of years ago, water was cheap and abundant, and no-one seemed to care about water," says Prof Thinus Booysen who is passionate about water conservation.

"In May, a few students and researchers at the Department of Electrical and Electronic Engineering, and a University spinoff called Bridgiot, embarked on designing a novel water meter, called Dropula. Rather than intended to be a billing solution, Dropula was designed with the explicit intention of changing user behaviour, which required data with high resolution and high sampling rates, reported with novel wireless communication technologies. More importantly though, the information had to be processed and presented in a straightforward highly visualised and accessible platform so that even school children could understand," continues Prof Booysen who heads this initiative.

Finally, the solution needed intelligent anomaly detection and real-time notifications.

After initial prototyping and testing at disparate locations (takeaways, households, cafés), the team visited a local primary school, which used as much as 23 kl of water on a weekday. After installing the Dropula and presenting the easily digested analytics to staff and students, consumption dropped significantly,

and currently sits at an average of 5 kl per day. By March 2018, the school has saved R150 801 (almost 3 million litres of water).

Upon hearing of the successes at the first school on Cape Talk Radio, Shoprite piloted the technology at Hector Peterson Secondary School in Wallacedene, where the consumption dropped from a staggering 52 kl per weekday, to a best of 4 kl (slipped to a current 15 kl/day). From September 2017 until March 2018 the school saved a total of R275 192 (more than 5 million litres of water).

In November, the #SmartWaterMeterChallenge was launched in partnership with Shoprite, Cape Talk, Bridgiot, Pragma, and later the Western Cape Education Department, in which corporates could sponsor a school to receive two stages of intervention, namely a plumbing maintenance stage, followed by a behavioural change intervention. In total 93 corporates sponsored 358 schools.

By the end of March 2018, 202 schools had been equipped with the Dropula, and although only 57 schools had completed their full maintenance stage, the schools were already saving a cumulative 500 kl/day. In the five months leading up to the end of March 2018, the project had already saved 40 million litres of water. In addition to reducing the water load in a drought-stricken Cape Town, this resulted in R2,75 million savings for the schools – money that can be put to better use in a challenged education system.

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 done as part of a larger system, students are exposed to 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 include superconducting elements, nanosensors, electromagnetic compatibility, microwave filters and non-linear circuits. An antenna and microwave laboratory, supported by sophisticated instrumentation and powerful computing facilities, provides the infrastructure for research work.

Electrical Energy

This division focuses in 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. In renewable energy, the focus is on photovoltaic solar energy, wind generator systems, system identification and grid integration. The 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 amongst others advanced insulator tests and research.

Telecommunications and Informatics

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

Electrical Eenergy

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Industrial Engineering



Chad Swart (right) showing interns Thembeke Nxiba (middle) and Teboho Makoala the newly-machined titanium turbine blade that was manufactured on the brand new DMG Turn-Mill as part of a project funded by the Department of Science and Technology (DST). The new Turn-Mill, and several other state-of-the-art machines, are situated in the Stellenbosch Technology Centre (STC) which is part of the Department of Industrial Engineering.

3 Highlights



Madelein Louw, winner of the 2017 ECSA Medal of Merit.

Exceptional students

Students in the Department of Industrial Engineering shone in 2017. They collected top awards in various categories.

With an average of 89,9%, Madelein Louw received the Engineering Council of South Africa's (ECSA) Medal of Merit Award that is awarded annually to the Maties engineering student with the best average over four years.

Jacqueline Kazmaier won Stellenbosch University's Chancellor's Medal, the highest honour bestowed on a final-year or postgraduate student who has excelled both academically and in all facets of campus life. Ms Kazmaier passed all her modules with distinction and maintained an average of 89,7%. Apart from being a brilliant student, she is also a talented photographer and graphic designer. She sings, dances and plays both the violin and the piano. Furthermore, she is a member of the Maties Surfing Society and the Maties Volleyball Society.

Christiaan van der Walt won the S₂A₃ Bronze Medal of the South African Association for the Advancement of

Science which is awarded to the University's most outstanding master's student in a scientific discipline. He achieved 95% for his master's thesis titled *Mathematical models for sustainable wealth redistribution*.

His supervisor was Prof Jan van Vuuren, Head of the Stellenbosch Unit for Operations Research in Engineering (SUnORE). Mr Van der Walt also won a (Paul Roos) Rhodes Scholarship which enabled him to go to Oxford University in September 2017 to do a further master's degrees in applied mathematics and scientific computing (2017–2018), and a doctorate in mathematics (2018–2021).

Award-winning academics

2017 was indeed a proud year in the history of the Department of Industrial Engineering. Not only did its students excel – three academics were also recognised for their exceptional contributions. Furthermore, a research group snatched up most of the prizes awarded at a conference.

Prof Corne Schutte, Chair of the Department, was selected as the Faculty of Engineering's Lecturer of the

Year. This award is made annually to an academic who has made a significant long-term impact on the Faculty.

Two academics were honoured with SAIIE awards at a gala function of the Southern African Institute for Industrial Engineering in July. The SAIIE awards honour and celebrate outstanding contributions to industrial engineering in Southern Africa. Prof James Bekker received the award for Outstanding Industrial Engineering Educator, while Prof Jan van Vuuren was the recipient of the Outstanding Industrial Engineering Researcher award. An alumnus of the Department, Arno van der Merwe (CEO and President of the Beijing Benz Automotive Company), won the Kris Adendorff award for Prominent Industrial Engineering Professional.

The Stellenbosch Unit for Operations Research in Engineering (SUnORE) snatched up seven of the eight awards during the conference of the Operations Research Society of South Africa (ORSSA) held in September, clearly making their mark as a force to be reckoned with.

High profile appointment

Industrial Engineering was extremely honoured to appoint Prof Calie Pistorius as Extraordinary Professor. This high-profile appointment adds more gravitas to the academic and research capacity of the Department.

Prof Pistorius is a former Vice-Chancellor and Principal of the University of Pretoria and a former Vice-Chancellor of the University of Hull (2009–2017).

He recently established DeltaHedron Ltd, a UK-based business consultancy firm with a global reach that specialises in the management of technological innovation.

Prof Pistorius says: “I am delighted and honoured to have been appointed. It is a very dynamic department with an excellent reputation. I would like to contribute by bringing the experience I have gained as an engineer, manager, academic and researcher, as well as in the industry. I am passionate about innovation – the conceptualisation, development and implementation of new things. I look forward to working with colleagues and students, mostly with regard to research. The engineering profession is constantly evolving and we need to ensure that the training of engineers is ahead of the curve.”

Prof Pistorius delivered a guest lecture at the Faculty on 11 September to a packed audience of staff, students and other visitors. He explored the impact, opportunities and risks presented by emerging technologies. A core message of the lecture was that all companies are technology based – which poses many opportunities but also risks and threats especially if innovation management is not strategically managed.

Research Output	
Journal Articles (Subsidised)	72
Proceedings International	31
Proceedings National	22
Books	1
Chapters in Books	1
Doctoral completed	13
Master's completed	30



Prof Corne Schutte
Chair: Industrial Engineering.

Towards improving beneficiation policy



Master's student Herman van Zyl, (right) visited a steel plant (left) as part of his research into the barriers facing the manganese industry in South Africa.

In 2015, the Department of Industrial Engineering launched a research programme focused on finding innovative ways to improve the analysis and implementation of mineral beneficiation policy. The research programme thus investigates the question of whether South Africa (and other mineral rich countries) should export minerals in a raw format and import final products, or rather seek to process minerals locally into final consumer goods.

The research group has collaborated with various stakeholders. In particular, researchers from Mintek and KU Leuven in Belgium have been directly involved in the research, participating as co-authors of research papers. Joint workshops have also been held with the Institute for African Alternatives and research groups at the University of Cape Town focusing on similar research themes.

One of the key findings of the research is that blanket policies are prone to lead to sub-optimal development outcomes. In particular, although the initial results indicate that the “beneficiation narrative” (i.e. that countries should process their minerals before exports) seems to make sense as a conceptual generalisation, countries may be better off following a “frog-leaping” approach to industrial policy instead of a strict step-by-step beneficiation approach. Based on this finding, the research group has focused on developing a suite of tools that mineral producing countries can use in order to make better informed industrial policy decisions that maximise developmental outcomes.

Some of the preliminary outcomes from the project include:

- An identification of the key barriers that restrict growth throughout the manganese value chain.
- The development of a new model to use publicly available sustainability disclosures to evaluate the triple bottom line impact of different industries (with a case study completed on the platinum industry).
- The development of a new framework to evaluate the strategic value of different product groups in value chains in terms of their potential to support the development and growth of countries (with case studies underway on the iron and steel, aerospace, manganese, titanium, automotive and platinum industries).
- The development of a framework that supports the analysis of the drivers of industrial location decision-making – why industries choose to locate in specific countries (with a case study underway on the iron and steel industry and titanium industry).

The research group has also participated in various international forums. In particular, researchers have presented the work emanating from the research at the European Trade Study Group 2017, the Conference on Global Production 2017, Harnessing the Extractive Industries for Development in sub-Saharan Africa 2016, two conferences of the Southern African Institute for Industrial Engineering (2016 and 2017) and the Global Conference on Sustainable Manufacturing 2016. (More information: wouterb@sun.ac.za).

Engineering Management

Includes fields such as project-, risk-, innovation-, quality- and performance management, and feasibility studies in the wider sense:

- Enterprise engineering: analysis of enterprises (design, implement, operate) including knowledge and information-, innovation-, financial- and technology management.
- Sustainable systems: the transition to a more sustainable economy and society, placing emphasis on management of infrastructure/technology, including planning and design.
- Health systems engineering: conceptualising novel, engineering-based solutions to challenges facing the healthcare sector. The research hub is specifically focused on facilitating improved healthcare delivery within the public sector in sub-Saharan Africa.
- Innovation for Inclusive Development (I4ID): analysis, development and evaluation of inclusive innovations, inclusive innovation systems and innovation platforms. Exploring how I4ID may provide solutions to societal problems (access to clean water, healthcare, financial services, etc.).
- Commercial readiness of emerging technologies: Technology Readiness Level (TRL) is widely used as a measure of technology maturity. However, TRL is not necessarily a good indicator of commercial readiness of emerging technologies. Commercial readiness indicators form a roadmap for commercialisation for products and services in all sectors of wealth creation.
- Physical asset management: the systematic and coordinated activities through which organisations optimally and sustainably manage their assets over their respective life-cycles – a multifaceted discipline considering the strategic, tactical and operational aspects of an organisation's portfolio of assets.

Manufacturing

Focuses on development of resource efficient process chains to ensure sustainable manufacturing as value creation system of products, but also for wider application in the services sector:

- Digital design systems: the design thinking approach of product development from conceptual to Computer-Aided Design (CAD).
- Rapid prototyping: transforms these digital designs into physical products using rapid additive- or subtractive technologies.

- Metrology: analysis, development and evaluation of quality for these manufactured products and research advanced methods and technologies to reverse engineer future product innovations.
- Robotics: the application of industrial robots in manufacturing. Human/robot interaction is fundamental for the new industrial revolution, Industry 4.0.
- Micromanufacturing: involves micromachining (milling and turning) and microassembly of microproducts in which micromaterial handling systems are utilised.

Operations Management

- Supply chain management: supply network design, performance management and feasibility studies in the wider sense, to contribute to efficient supply chains.
- The PRASA Engineering Research Chair: Research focus of the Chair is the improvement of operational activities of PRASA, with specific focus on engineering solutions, maintenance management and operations management, best suited for the rail sector.

Systems Modelling, Operations Research and Decision Support

Focuses on the development of mathematical models and their incorporation into computerised systems aimed at supporting scientifically justifiable and effective decisions in industry. These models draw from the scientific fields of applied mathematics, statistics, industrial engineering and computer science and are applicable in the context of complex problems which admit a large variety of trade-off solutions. Strong decision support ties exist with a number of industry partners in the agricultural, retail, banking, insurance and military sectors, as well as various parastatals, NGOs and non-profit organisations. Examples are:

- Routing and scheduling decisions for fleets of delivery vehicles.
- Employee duty roster or timetabling decisions for the manufacturing and health sectors.
- Shelf-space allocation and inventory decisions for retailers.
- Crop irrigation and agricultural pest-control strategy decisions.
- Power generator maintenance scheduling decisions in the energy sector.
- Facility location decisions for effective supply chain logistics.
- Optimal facility or production plant layout.

Chair

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Women in Engineering



An annual Women in Engineering afternoon was launched in 2003 to promote engineering amongst Grade 11 and 12 female learners and to dispel the myth that engineering is for men only. This event, which usually draws about 250 participants, has played an important marketing role as women already make out between 20% to 25% of undergraduate classes. On the photograph is Janay Snyman (Physical Sciences teacher at Rhodes High School) with her learners who attended the function in 2017.

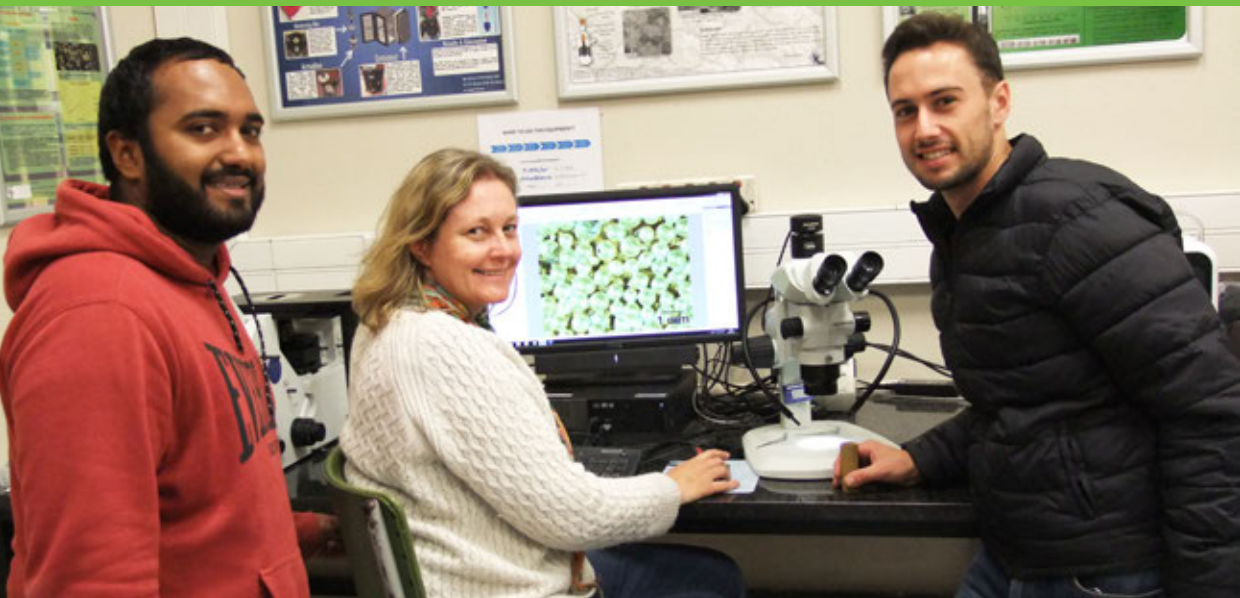
[See our Outreach Programmes on page 48.](#)

Mechanical and Mechatronic Engineering



Students make final adjustments before the annual competition where the Mechatronics 424 class compete against each other in a prescribed project.

3 Highlights



Prof Deborah Blaine in the Microscope Laboratory with postgraduate students Preyin Govender (left) and Jacques Piek, evaluating the microstructure of a sintered bronze filter under a stereo microscope.

First female Professor

In January 2017 the Department of Mechanical and Mechatronic Engineering appointed its first female Associate Professor, Prof Deborah Blaine.

Her interests in engineering awakened at an early age when she visited her father's factory. "I liked seeing how stuff was made and the efficiency of the production line," she says. "I chose mechanical engineering, because it is the broadest of the disciplines and because it is the discipline where mechanical structures, materials and science meet."

Of the five women in her first-year class of 90, she was the only one to obtain her BEng (Mechanical) in 1996. She pursued her interest in materials engineering by doing a PhD in Engineering Science and Mechanics at the Pennsylvania State University in the USA graduating in 2004. "Here I worked in my exact field of interest, namely sintered products. I was part of a strong research group led by Prof Rand German, a world-renowned expert. I had the opportunity to teach some of his classes when he went on sabbatical.

"I thought it would be good to acquire experience in industry and joined Bleistahl Produktion in Germany, the number one producer of valve seat inserts in the European Union," she adds. "I worked in the materials research and development office and helped develop a new material."

In 2007 she joined the Department of Mechanical and Mechatronic Engineering at Stellenbosch University. She has been involved in the South African Institution of Mechanical Engineering since 2008 and served as Chair of the Western Cape Branch between 2011 and 2013.

Prof Blaine has a passion for teaching and was a member of the founding board of the SA Society for Engineering Education. "I enjoy research, but especially teaching. While teaching some of Prof Rand's classes at Penn State, I realised how much I liked to explain things to people. I enjoy the challenge to find new ways to explain and present information when some students do not grasp it. I think this is why I became a lecturer. Helping people unpack information and build knowledge brings me immense satisfaction. I feel I can make a difference."

Sasol's solid support

In 2018 Sasol continued its solid support of research in the field of fuels and internal combustion engines at Stellenbosch University. This support started nine years ago when Richard Haines joined the Department of Mechanical and Mechatronic Engineering and identified a need for test equipment for teaching and research purposes. When he approached Sasol for support, his invaluable experience in the field of internal combustion engines and industry networks inspired Sasol to donate high value research hardware assets to the University.

In 2016 Sasol provided a grant of R500 000 for research on high octane and oxygenated fuel, which was followed up with a further grant of R500 000 in 2017 to complete the project.

In the Internal Combustion Laboratory an old Cooperative Fuels Research (CFR) engine was upgraded and modified to test specialised fuel formulations. “This CFR engine delivered excellent results,” says Mr Haines. “When we applied for another Sasol research grant for a further research project on high octane blending behaviour, we received funding of R485 000 as a result of the success and capability of this unique engine.”

Regarding Sasol’s long relationship with the Department of Mechanical and Mechatronic Engineering, Dr Gareth Floweday (Sasol Senior Mechanical Engineer, Energy Technology) says: “Sasol has a very long history of supporting research at SA universities. For example, Sasol’s Thematic Research Grants have funded over R200 million worth of SA university research since 2005. More specifically, the Sasol Energy business has a keen strategic interest to support fuel and engine research at universities. Today, the Internal Combustion Laboratory in Stellenbosch University’s Mechanical and Mechatronic Engineering Department is arguably the best and most active of its kind in the country. We see plenty of potential for sustained research collaboration between industry and universities.”

Calibre of students impresses industry

The Department does its utmost to provide industry with graduates of high calibre. It is therefore indeed a feather in the cap of the Department and its students when industry expresses its appreciation as seen below:

In their final year of studies, Mechanical and Mechatronic BEng students apply the knowledge garnered from their first to third years on a complex engineering problem. Sarah McEwan was tasked with the challenge to improve current nasal mask and prong designs of neonate continuous positive airway pressure systems. These systems assist neonates to establish and maintain lung volume and is commonly used as a therapy for respiratory distress syndrome.

Although these systems are effective in their function, the nasal prongs and mask designs are suboptimal in terms of fit to the sub-Saharan facial geometry. This leads to short and long-term nasal trauma, e.g. snubbing, necrosis, nasal flaring, etc. Ms McEwan performed a comprehensive literature review and with the help of a neonatologist, Dr Ricky Dippenaar, was able to pinpoint current drawbacks of the mask and prong designs in terms of use on the sub-Saharan population. This enabled Ms McEwan to formulate different concepts which could then be prototyped using 3D printing and casting methods. She was able to also incorporate her artistic skills when she moulded

Research Output	
Journal Articles (subsidised)	41
Proceedings International	24
Proceedings National	6
Doctoral completed	9
Master's completed	47

neonate facial phantom models on which her prototypes could be tested. Tests revealed that there were no pressure concentrations (cause of nasal trauma) on the nasal area.

Ms McEwan received a distinction for her final-year project, but more impressive is the feedback from the manufacturer in Europe, Brian Pierro (R&D Director Vyaire Medical):

“The student did some great work, I’d recommend hiring her! We had made several similar concepts of hybrid mask/prong designs. Her work is impressive given the tools she had. She landed in a similar spot as us for next steps. Please send my nod of approval to her and the team.”



Prof Kristiaan Schreve
Chair: Mechanical and Mechatronic Engineering.



New approaches to Biomedical Engineering (BME)



The younger generation was well represented at SABEC2018.

Prof Pieter Fourie, Head of BERG, (left) and Dr David Martin, one of the keynote speakers at SABEC2018.

The potential for innovation and human capacity building in the fast-growing field of Biomedical Engineering (BME) is huge. Local and international experts discussed this at the third South African Biomedical Engineering conference (SABEC2018) held in Stellenbosch in April. The theme was the revision and improvement of approaches to research and development.

SABEC2018 was presented by the SU Institute for Biomedical Engineering (IBE). BME is a progressive and exciting multidisciplinary field that aims to solve health-related problems using biosciences, physics, mathematics, and engineering at the intersections of biology, medicine and health sciences. The conference format included both commercial/industry and technical/academic tracks.

"This year we presented a conference with a difference," says Prof Martin Nieuwoudt, IBE Director. "We showcased an ecosystem designed to more effectively meet the needs of quality and affordable healthcare, through research, development, commercialisation and industrialisation of BME solutions. This ecosystem is by definition *open* and relies on partnerships between academia and industry to ensure success."

Dayle Wheeler, Director of Innovation4Life, who acted as a business partner for the conference, comments: "BME is the answer to affordable healthcare solutions for Africa. The fact that we mostly import products, while losing our BME students to overseas companies highlights the need to create a more gainful local industry."

"The conference was more than just about delivering good research papers," notes Prof Pieter Fourie, Engineer, Paediatrician, and Head of the Biomedical Engineering Research Group (BERG). "We demonstrated how good ideas by postgraduate students can be commercialised with assistance from industry partners. This could take the form of partnering, patenting,

licensing, manufacturing and creating spin-off companies. This is a new integrated approach to BME for SA universities."

A range of topics were covered, for example, nano- and microtechnology, biomechanics, neuroscience and technology, medical devices, cell, tissue, genetic engineering, E-health, health systems, device regulation and commercialisation. A special draw-card was an international keynote speaker, Dr David Martin, founder and CEO of M-CAM. Dr Martin is a world-renowned expert on intellectual property evaluation and creator of the IQ100 index that has outperformed the NASDAQ since its inception.

SABEC2018 drew from, among others, the IBE, BERG, Katleho-Biomedical, a joint venture between SU's technology transfer company, InnovUS and Innovation4Life. The latter company's focus is making life better through innovation and commercialisation in the biotechnology sphere. This is done by working as an incubator to develop and commercialise engineering concepts and technologies emanating from within the University.

Looking back at the Conference, Prof Nieuwoudt says: "The workshop at the end, *What does the SA Medical Devices industry need to grow?*, certainly achieved its aim. It elicited the opinions of the entire range of SA players. As a result, there is a renewed spirit of inclusivity among the members of the BME and Medical Devices community. This will lead to a more synchronised and focused message which, in turn, can be leveraged to access national funding for purposes of infrastructural and human capacity building. We are now working at defining a massive transformative purpose, a *rally-call*, which will unify all of our efforts towards a common goal. At SU at least, we have demonstrated our commitment and leadership with respect to realising this vision. We are open for business!"

Energy and the Environment

In close collaboration with the Centre for Renewable and Sustainable Energy Studies, the Department contributes towards 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. Uniquely South African solutions to concentrating solar thermal power and energy storage systems are researched. The group's world-leading research in air-cooled heat exchangers and cooling towers is well known. The group can test fans, heat exchangers and cooling tower fills to international standards. This experimental capability, combined with strong computational expertise, enable the group to develop special fans, compressors and turbines, e.g. industrial applications, but also ocean current, wind, and solar energy exploitation-, and air-cooled systems. Two-phase flow expertise has attracted the nuclear industry's interest with the application of heat pipes as passive heat transfer devices. 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.

Biomedical Engineering

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

Mechanics and Dynamics

Activities are divided into fundamental research on materials, behaviour of structures and failure mechanisms and criteria. The materials research focuses on powder metal (mainly titanium and its alloys) processing and products, continuous fibre-reinforced thermoset composites for aviation components and structures, material property

extraction using digital image and volume correlation, characterisation of granular materials and qualification of additive manufactured parts for biomedical and aerospace components. The structures research looks for 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. The research into failure mechanisms and criteria is focused on composite material failure phenomena, fracture and creep deformation of steels.

Mechatronics, Automation and Design

Diverse mechatronic systems such as reconfigurable manufacturing systems, unmanned aerial vehicles, robots and medical devices are researched. The research includes development design methodologies for such systems. It finds applications in automation of assembly systems, inspection and quality control using machine vision, reverse engineering, micrometrology and calibration and maintenance of heliostats for concentrating solar power systems.

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. Their work is backed up with excellent experimental work in well-equipped laboratories. The DEM work is applied to mining and earthmoving equipment, particle dampers, conveyors, etc. The optimisation methods are often linked to 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 with emphasis on solidification analysis and segregation. Besides workstations and GPU (graphics processing unit)-based computing this work is supported by access to the University's High Performance Computing Centre that was created mainly due to funding from the Faculty of Engineering.

Design and Mechatronics

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Process Engineering



Master's student Marielle Hurter with the test unit that she constructed for the evaluation of hydraulic flux and concentration polarisation behaviour in forward osmosis systems.

3 Highlights



Dr Mohsen Mandegari and Dr Somayeh Farzad who were amongst the 2017 Top 20 Postdoctoral Researchers at Stellenbosch University.

New challenge leads to postdoc awards

Two postdoctoral fellows in the Department of Process Engineering were amongst the 2017 Top 20 Postdoctoral Researchers at Stellenbosch University. Dr Mohsen Mandegari and Dr Somayeh Farzad, a Persian couple from Iran, are delighted with the recognition they received and regard it as a wonderful reward after a lot of hard work. "For us, 2017 was a glorious year!" they exclaim in unison.

In 2014 Dr Mandegari and Dr Farzad were looking for a new challenge after working in Iran as an engineering manager and an assistant professor respectively for some time. They first considered career opportunities in Canada and Denmark, but subsequently joined the bioprocess research group of Prof Johann Görgens. They brought with them valuable industrial experience and process simulation knowledge, but did not have any experience in their new field.

"Our research covers valorisation of waste material, such as agricultural residues, tyres and plastics that are converted into valuable chemicals and fuels. As it was a new field for both of us, we spent the first and second years to learn about the subject. In order to achieve our goal, we spent many evenings and weekends working," says Dr Mandegari.

At Stellenbosch University there are approximately 350 postdocs from South Africa and beyond. Therefore, it is indeed a great achievement to be regarded amongst the top 20.

The award-winning couple feel the professional experience gained in Iran may have played a role in the recognition they received from SU, as their publications are possibly more compelling and practical instead of just scientific.

Department's first honorary doctorate

The Department of Process Engineering is proud of the honorary Doctorate that Stellenbosch University conferred upon one if its alumni, the first if its kind in the history of this Department.

Prof Markus Reuter received the degree Doctor of Engineering (DEng), *honoris causa*, at the December 2017 graduation ceremony for his outstanding contribution to the science, technology and industry of metals production, recycling and resource efficiency, and his continued commitment to equip young engineers as the thought leaders of tomorrow who will take up the baton of securing a sustainable future for all.

Skilfully integrating teaching, research and industrial practice, Prof Reuter has helped society onto a more sustainable path, empowering stakeholders from classrooms to boardrooms and the halls of power to take informed decisions to apply resources more sustainably.

Born and bred in Stellenbosch, he holds the degrees BEng (Chemical Engineering), MEng, PhD and DEng from Stellenbosch University. His stellar research and teaching have also earned him a Doctorate *honoris causa* from University of Liège, Belgium.

His career attests to unequalled proficiency in both academia and industry. As an academic, he has been attached to several prominent tertiary institutions worldwide. Particularly his professorship at Delft University of Technology yielded a world-leading research group on recycling and sustainable technology, and many advances in sustainable product design. In industry, he excelled as chief executive technologist at Ausmelt in Australia and technology management director at Finnish firm Outotec. In his current role as director at the Helmholtz Institute Freiberg for Resource Technology, he continues to develop the tools to enable a circular economy that minimises resource inputs and waste.

Research award for bright young academic

One of the Department's bright young academics, Dr Neill Goosen, was selected as the Faculty's 2017 Upcoming Researcher of the Year. He focuses on the development and optimisation of processes that produce value-added products from agricultural and food processing by-products, for application in both the agricultural and food sectors.

Dr Goosen was appointed senior lecturer in the Department in 2013 and has been successful in obtaining

significant research funding. In 2017 alone, he negotiated a (THRIP) research contract of R12 million for the development and demonstration of production processes to manufacture value-added ingredients from South African kelp.

"In my profession as academic and researcher, I am privileged to work with extremely talented people," he says. "I find especially the research side of my work very stimulating. I work in fields that are removed from the traditional core areas found in engineering, namely agriculture and aquaculture. I feel I have really found my niche and I enjoy working with other people and groups."

Research Output	
Journal Articles (subsidised)	43
Proceedings International	5
Chapters in Books	3
Doctoral completed	5
Master's completed	32

Prof André Burger
Chair: Process Engineering.



Computer vision for process monitoring



From the left: Ernst Nienaber (PhD student), Zander Horn (PhD student), Emile Lochner (rapid prototype developer from Soldersmith) and Dr Lidia Auret (senior lecturer) at one of the spiral concentrator rigs at the Department of Process Engineering.

With “machine learning”, “computer vision”, and “data science” becoming terms that future engineers will need to become familiar with, recent partnerships between mining companies, a passionate entrepreneur and research students at Process Engineering are helping to train undergraduate and postgraduate students in these concepts.

Recent projects have investigated the use of computer vision in mineral processing applications. Applications include the monitoring of rocks, slurries (ore/water mixtures) and pellets at various stages of processing in an industrial plant. Computer vision sensor technology has been well established in some of these applications for many years, but exciting new developments in machine learning algorithms provide interesting challenges for research projects.

Spiral concentrators are simple mechanical helix-shaped open pipes that allow valuable minerals to separate from less valuable minerals as slurry flows down the spiral. Depending on the colouring of the minerals present in the slurry, images of the slurry are used to deduce the extent of separation between minerals. For example, black ilmenite is distinguishable from lighter quartz in heavy mineral sands industries.

TRONOX (heavy mineral sands operations), Glencore (chromite mineral processing plants) and Multotec (manufacturer of process equipment, including spiral concentrators) have been involved in recent research projects. In his undergraduate research project, Zander Horn developed a prototype control system (where a splitter is automatically positioned at the bottom of the spiral according to the visual appearance of the spiral slurry), while Ernst Nienaber developed algorithms to detect the interface between the minerals in the slurry from digital images. Mr Nienaber has also developed

optimal sensor placement algorithms: in a processing plant where spiral concentrators number in the hundreds to thousands, computer vision sensors are too expensive to place on all spiral concentrators, necessitating the determination of where the sensors should be placed to provide maximum benefit to the plant.

Another application of computer vision sensors is in froth flotation: to separate hydrophobic platinum-containing minerals from hydrophilic minerals, air is pumped through slurries, causing the platinum-containing minerals to attach to the bubbles. The appearance of the froth (its colour, texture, and velocity) contains a wealth of information that can potentially be exploited for optimal control of the separation process. In his MEng, Mr Horn applied recent developments in machine learning (convolutional neural networks) to the froth monitoring challenge.

Computer vision sensors can also be used for estimating the size of rocks or pellets on conveyors or rollers in processing plants. Johannes Rabie's project investigated how computer vision can be applied to a specific processing plant, a Glencore chromite operation in the North West.

A valuable partnership in these projects was made with a passionate entrepreneur who specialises in rapid prototype development. Emile Lochner from Soldersmith developed prototypes of the computer vision sensors that were demonstrated at the industrial partners for the spiral concentration and pellet size estimation projects. Through InnovUS, an agreement was set up to allow all students involved in the computer vision projects to receive the benefits of prototype development and sales.

Extractive Metallurgy

The sustainable production of valuable minerals and metals from ore or metal-containing waste material is critical for a sustainable future. Ore is a complex raw material, requiring a wide variety of treatment processes to unlock valuable minerals and metals. The group undertakes research into the fundamental concepts and application of such treatment processes. Key challenges include changing raw material characteristics (e.g. diminishing mineral/metal content as easy-to-access ore bodies are depleted), minimisation of energy and water usage (to minimise carbon footprint and reduce impact on scarce resources), as well as effectively dealing with the complex behaviour from the intricate flowsheets required to process heterogeneous, multiphase raw materials.

Waste Valorisation

The successful valorisation of wastes will allow closing the loop in the circular economy, moving closer to a sustainable future. Key challenges include separation and concentration of valuable products as well as functionalisation of relatively inert chemicals.

The group is active in three main areas:

- Waste tyre conversion to high-value chemicals (REDISA project).
- Electronic waste processing for metal recovery (lithium, gold, copper).
- Biological waste utilisation (e.g. wastewater, agricultural residues, fishery waste, etc.).

Separations Technology

The Separations Technology research group focuses on understanding the underlying fundamentals of thermal separation processes involving various hydrocarbons. Processes include traditional separation techniques such as distillation and liquid-liquid extraction, but also include advanced processes such as enhanced distillation and supercritical fluid fractionation. The research group focuses on the separation of compounds where the underlying systems may exhibit azeotropy and association due to hydrogen bonding, and the systems may involve molecules with varying polarity and asymmetrical structure. Ultimately, the aim of the research group is to understand how the structure of a molecule affects its macroscopic behaviour.

Bioresource Engineering

To ensure a sustainable future, biological resources need to be used optimally, and the group focuses on developing industrial processes that are safe, sustainable and profitable. The group's research revolves around the use of biological resources in the development of production processes, and can be subdivided into two classes: processes that employ biological resources (e.g. live organisms like yeasts or bacteria, or active biological molecules like enzymes) to transform raw materials into valuable products, or production processes that use biological raw materials as inputs. There is a strong interdisciplinary focus within the group, and frequent collaboration occurs with other disciplines at Stellenbosch University and with leading foreign institutions.

Water Technology

The group focuses on research and development aimed at addressing current local and international challenges in water provision. The objective is to improve existing water treatment technologies as well as develop new technologies that will contribute to addressing this global challenge. The group's strengths lie in membrane technology for water treatment and reuse (microfiltration, ultrafiltration, reverse osmosis, forward osmosis, membrane distillation and Donnan Dialysis), and in technologies that will be applicable and sustainable in developing economies. Current projects range from investigation and modelling of basic phenomena, to technology development leading to implementation in the field.

Chair

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Outreach programmes

Open Day

The annual Open Day makes learners, parents and the general public aware of the interesting world of the engineer and the vast career opportunities in this field.

Enquiries: Ms Tanya Ficker

Tel: +27 21 808 9403, e-mail: tanya@sun.ac.za

Engineering Winter Week

During the annual Winter Week, Grade 11 and 12 learners get a clear picture of the work of an engineer through presentations by lecturers and engineers, as well as visits to industries and laboratories.

Enquiries: Ms Portia Adonis

Tel: +27 21 808 4203, e-mail: winterweek@sun.ac.za

Women in Engineering

At the annual Women in Engineering afternoon, Grade 10 to 12 girls, who excel in Mathematics and Physical Sciences, find out more about engineering as a career for women when women engineers, lecturers and students address them.

Enquiries: Ms Avril Ford

Tel: +27 21 808 3614, e-mail: aford@sun.ac.za

Top Achiever Sessions

During sessions, top achievers (Grade 11 and 12) and their parents are informed about engineering as a career and the Faculty's degree programmes.

Enquiries: Mr August Engelbrecht

Tel: +27 21 808 4203, e-mail: august@sun.ac.za

First Generation Experience

Universities can be quite daunting if you have no experience of academic or tertiary institutions. In 2018 the Faculty launched this new outreach for Grade 11 and 12 top achievers, whose parents have not had the opportunity to study at a university. During a day visit they feel the exciting vibe of campus, hear about the Faculty of Engineering's degree programmes and other SET fields of study, and meet the Dean.

Enquiries: Mr August Engelbrecht

Tel: +27 21 808 4203, e-mail: august@sun.ac.za

Buddy Programme to facilitate integration

Engineering is a demanding and challenging programme and some students (especially from deep rural areas) find it difficult at first to adapt to the new environment and academic culture. During the first semester, senior students act as the students' "buddies" to facilitate their smooth integration.

Enquiries: Mr August Engelbrecht

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Leadership Development

Senior students follow a leadership module at the Frederik van Zyl Slabbert Institute for Student Leadership Development, which enables them to become well-rounded engineers who are better equipped to make a difference in society.

Enquiries: Ms Avril Ford

Tel: +27 21 808 3614, e-mail: aford@sun.ac.za

TRAC SA

The TRAC Programme, the biggest community interaction programme at Stellenbosch University, gives support in Physical Sciences and Mathematics in TRAC laboratories countrywide to learners in disadvantaged communities. It also provides vocational guidance regarding careers in the sciences, engineering and technological fields and assists learners to obtain funding for tertiary studies.

Enquiries: Ms Debbey Olivier

Tel: +27 21 808 4384, e-mail: debbey@sun.ac.za

Minquiz

Minquiz (organised by Mintek) is a science and technology quiz for Grade 12 learners that promotes careers in science and technology, especially in mining, mineral processing and geology. The Department of Process Engineering provides assistance in the Boland and the Western Cape.

Enquiries: Prof Christie Dorfling

Tel: +27 21 808 3674, e-mail: dorfling@sun.ac.za

CRSES Schools' Programme

This programme, run by the Centre for Renewable and Sustainable Energy Studies, provides professional development and learning material (free of charge) to assist educators in teaching renewable energy topics. It is implemented in collaboration with the Department of Education, WESSA Eco Schools, Fundisa for Change, Science Centres and Independent Power Producers.

Enquiries: Ms Therese Lambrechts

Tel: +27 21 808 3605, e-mail: therese@sun.ac.za

SUNSTEP

The SUNSTEP Programme provides learners the opportunity to build their own working electronic circuits. There are also workshops for educators.

Enquiries: Ms Miranda Myburgh

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