Alumni INGligting 2014

Nuusbrief van die Fakulteit Ingenieurswese, Universiteit Stellenbosch
Uitgegee deur die dekaan: Ingenieurswese. Redakteur: Liesel Koch, lkoch@sun.ac.za

November

Reünie vir jonger geslag Matie ingenieurs lewer rekordopkoms

Met 'n rekordopkoms het die jonger geslag Matie ingenieurs getoon dat hulle graag kontak met hul almal mater wil behou. Ongeveer 100 oudstudente van die Fakulteit Ingenienieurswese het die reünie vir die groep 2000 tot 2013 op 5 November by Durbanville Hills bygewoon.

Die dekaan, prof Hansie Knoetze, het by die geleentheid gesê: "Dis 'n besondere voorreg as ons alumni so bymekaarkom. Ons is baie bly om soveel van julle hier te sien."

Prof Knoetze het kortliks vertel van die stand van sake in die Fakulteit en het Universiteit Stellenbosch se Institusionele Voorneme en Strategie kortliks bespreek: die verbreding van toegang, die handhawing van die momentum van uitnemendheid asook die vergroting van die impak op die samelewing.

Hoogtepunte in die Fakulteit die afgelope jaar is die suksesvolle EC-SA-akkreditering van al ses die BIng-programme, die hoogste navorsingsuitsette ooit, die grootste BIng-inname, die meeste aantal nuwe registrasies vir MIng en PhD, asook die grootste groei in eksterne befondsing.

Hy het ook genoem dat die Nasionale Ontwikkelingsplan vereis dat die aantal ingenieursgraduandi in die land teen 2030 drie maal meer moet wees as tans. Om dit te kan bereik, sal daar elke jaar vir die volgende 15 jaar een Ingenieursfakulteit (groter as US of UK) tot stand gebring moet word.

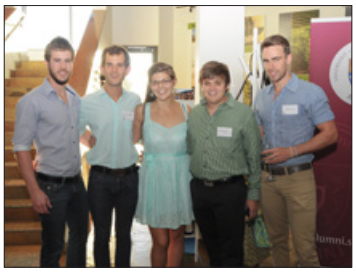
Prof Knoetze het ook 'n beroep of alumni gedoen om die Dekaansfonds te ondersteun. Dié Fonds fokus hoofsaaklik op beurse vir verdienstelike studente en apparaat vir laboratoria.

Hy het afgesluit met die woorde: "As Ingenieursfakulteit wil ons die beste graduandi aflewer, voorpunt navorsing doen, mense inspireer en help om Suid-Afrika op- en uit te bou om HOOP te gee aan almal rondom ons.

Pieter Uys (voormalige hoofuitvoerende beampte van Vodacom en tans uitvoerende beampte: strategiese beleggings, Remgro) het die gehoor geboei met sy interessante praatjie oor die geskiedenis en fenominale vooruitgang van tegnologie deur verskeie opwindende voorbeelde te demonstreer.

Met hierdie reünie het die Fakulteit nou oor die afgelope vyf jaar al die graduandigroepe van 1948 tot 2013 gedek.

Prof Hansie Knoetze en Pieter Uys.



Profiel: Jacques Germishuizen

Langtermynplanne loop klopdisselboom

'n Buurman se stokperdjie wat hom as jong seun interesseer en fassineer het, het die fondament vir sy toekomstige loopbaan gelê. "Ek het verskeie rolmodelle gehad, maar Oom Douglas Lawrie, ons buurman, was definitief een van die belangrikstes. Ek het altyd oor naweke by hom in sy motorhuis 'n bietjie houtwerk gedoen," sê Jacques Germishuizen, wat reeds 14 jaar as ingenieur by Siemens in Duitsland werk.

"My gunstelingvakke by die Hoër Tegniese Skool Drostdy in Worcester was elektrisiëns- en houtwerk. Die meeste van my klasmaats het besluit om ná skool by die Kaapse Technikon te gaan studeer, maar Oom Lawrie, 'n ingenieur, het my inspireer om ingenieurswese by 'n universiteit te gaan doen.

"In Oom Lawrie se motorhuis het ek geleer dat min dinge die eerste keer werk. Deur goeie beplanning kan 'n mens die aantal iterasies of nodige aanpassings tot 'n minimum beperk. Eksperimente met elektriese toestelle het my reeds van vroeg af interesseer. My gekrap daaraan het gemaak dat van my ouers se toestelle soms in die stof gebyt het, maar meer dikwels nuwe asem gekry het."

Die belangstelling in elektriese toestelle het daartoe gelei dat Jacques Elektriese en Elektroniese Ingenieurswese aan die Universiteit Stellenbosch gaan studeer het. "Die Universiteit was naby, het 'n graad in beide elektriese en elektroniese ingenieurswese aangebied en was destyds reeds bekend vir gehalte-onderrig.

"Die gogga om my M te doen, het my eers in 1997 in my finale jaar van BIng gebyt. Veral die M-onderwerp, naamlik *Die optimering van 'n elektriese motor in 'n trekkragtoepassing met behulp van die eindige elementmetode*, het my die gevoel gegee dat ek nou agter die kap van die byl gekom het.

"Na afloop van my M het ek in April 2000 by Siemens in Neurenberg, Duitsland, begin werk. Die oorspronklike idee was om slegs drie maande daar te werk en te toer. Gedurende hierdie tydperk was daar 'n pos beskikbaar as ontwerpsingenieur vir masjiene wat in trekkragaandryfstelsels gebruik word. Aangesien dit so reg in my kraal was en ek reeds goed in die afdeling ingeskakel het, het ek suksesvol om die pos aansoek gedoen.

Jacques staan by een van sy gunsteling vervaardigingsprosesse van die trekkrag induksiemotors: Induksiesoldering van die kortsluitring. Die kortsluitring word met behulp van induksieverwarming tot ´n paar honderd grade verwarm.

"Van my eerste projekte was om die RSM (reluktansie-sinchroonmasjien) vir lokomotiewe te ondersoek en trekkraginduksiemasjiene te ontwerp. Die uitdagendste projek was die ontwerp van 'n permanent-magneetmasjien vir direkte aandrywing waarvan die eerste veldtoetse van die prototipes op die moltrein van München getoets is. Die ondervinding in die Elektriese Masjienelaboratorium onder leiding van prof Maarten Kamper het my nie net in 'n goeie posisie geplaas nie, maar ook goed voorberei vir veral my ontwerpprojekte."

Na ongeveer agt jaar het Jacques geskuif na die navorsing- en ontwikkelingsafdeling in Ruhstorf waar die hooffokus was op laespoed-windkraggenerators en toepassings wat met permanent-magneettegnologie vervang kon word. Gedurende die tydperk het hy in 2009 sy PhD onder leiding van prof Maarten Kamper en dr Andreas Jöckel verwerf. In 2011 is hy terug Neurenberg toe as projekbestuurder vir die ontwikkeling van ontwerpsagteware vir elektriese masjiene.

"Dié sagteware word tans gebruik in die afdelings navorsing en ontwikkeling asook produkontwikkeling in Neurenberg, Berlyn en Ruhstorf. Elke fabriek fokus op spesifieke produkte en kliënte. Die ontwikkeling van eie ontwerpsagteware word hoofsaaklik om twee hoofredes gedoen. Eerstens word die produkspesifikasies deur kliënte se spesifieke behoeftes en vereistes bepaal. Tweedens word die kennis en vaardighede eie aan Siemens beskerm.

"Mense sê dikwels dat die fisika vir alle elektriese motors dieselfde is. Waarom is dit dan nodig om ons eie sagteware te ontwikkel en nie 'n produk te koop nie? Die fisika vir ons produkte is dieselfde. Die spesifikasies waaronder die produkte gebruik word, die vervaardigingsproses en selfs die ontwerpsoorwegings en strategie is egter verskillend. Daarby verander die aspekte voordurend en moet aangepas word soos kliënte se behoeftes verander.

"Die ontwikkeling van konsepte en sagteware wat met hierdie veranderinge byhou, is uitdagend en bied gedurig nuwe struikelblokke wat oorkom moet word. Die moontlikheid om eie ervaring toe te pas, aan spanpogings deel te neem, en uiteindelik vorendag te kom met 'n oplossing waarmee almal tevrede is, maak dit keer op keer 'n plesier."

Wat die lewe in Duitsland betref, sê Jacques: "Ek het ervaar dat 'n mens as Suid-Afrikaner goed in Duitsland kan aanpas. Opvallend vir my was egter die besef hoe 'n groot rol die weersomstandighede in sekere gebruike speel. In Suid-Afrika, byvoorbeeld, is dit algemeen om nog so 'n bietjie by die hekkie te kuier voor die gaste uiteindelik vertrek. In die Duitse winter is dit egter nie aangenaam om by 0 °C buite te kuier nie! Boonop gaan dit ook gepaard met die aan- en uittrekkery van dik jasse. Waar 'n vleisbraai in Suid-Afrika net die beste bly, is 'n ou braaibroodjie maar skaars in Duitsland. Aan die ander kant bied die leer van 'n nuwe taal baie nuwe moontlikhede."

Jacques en sy Duitse lewensmaat, Elke, het 'n seun, Jan, wat vyftien maande oud is. As deel van die Duitse gebruik om "ouer-verlof" ná die geboorte van 'n kind aan ouers toe te ken, kon hulle tot middel Oktober vanjaar twee maande in Suid-Afrika deurbring. "Dit was 'n wonderlike tyd om so intensief ons kind se ontwikkeling te kon waarneem," sê hy.

Jacques se seun word tweetalig in Duits en Afrikaans opgevoed. Jacques, wat Duits goed magtig is, skeep egter nie sy Suid-Afrikaanse wortels af nie. "Ek leer tans ook Xhosa – 'n droom wat ek nog altyd gekoester het. Duitsland is natuurlik nou nie juis die beste plek om dié taal te oefen nie. Op die oomblik het ek 'n kollega in Neurenberg wat van Midrand af kom en Xhosa praat. Ons woon naby aan mekaar en ek kan dus lekker my Xhosavaardighede met hom oefen. En YouTube is ook 'n goeie bron.

"Daar is 'n tawwe tongknoper in Xhosa wat ek al bemeester het: *Iqaqa lizeqikaqika kuqaqaqa lide liqhawuke uqhoqhoqho* (Die muishond rol in die gras totdat sy gorrelpyp breek). In Suid-Afrika het ek al dikwels met die tongknoper voor Xhosasprekendes gespog. Die goeie reaksie wat dit elke keer ontlok, inspireer my telkens om nog meer skouer aan die wiel te sit.

"My stokperdjie is nog altyd houtwerk. My werkswinkel is goed op stokperdjievlak ingerig – soortgelyk aan oom Lawrie s'n. Dikwels kom die bure se kinders inloer en probeer hand bysit." Hopelik sal die geskiedenis hom herhaal en Jacques op sy beurt hierdie kinders, soos Oom Lawrie, inspireer om ingenieurs te word.

Oor wie die belangrike mense in sy lewe is, sê Jacques: "Eintlik almal – selfs die booswigte. Hulle herinner my telkens daaraan om my humeur in toom te hou." Sy lewensleuse, *Glimlag, en moenie reageer op dinge wat jy dink ander mense dink nie*, sluit hierby aan.

Jacques is in die gelukkige posisie dat sy langtermyndoelwit reeds veertien jaar gelede vorm aangeneem het toe hy sy loopbaan by Siemens begin het. "Die kombinasie van my werk as ingenieur in Duitsland, asook die moontlikheid om die taal te leer, is reeds 'n verwesenliking daarvan. Tans is dit noodsaaklik om voortdurend nuwe geleenthede te ontdek en die beste daarvan te maak."

Met só 'n positiewe ingesteldheid is dit te verstane dat Jacques homself met dié paar woorde opsom: *Vriendelik*, *klopdisselboom* en *begin dadelik*.

Jacques en sy seun, Jan, ontspan 'n bietjie by Rhebokskloof aan die hang van Paarlberg tydens hul gesin se onlangse besoek aan Suid-Afrika.

Research: Ironless double-rotor radial flux permanent magnet motor

The Team, the Swallow and the Challenge

While carrying out a research project on a novel electric motor, a team of academics and students are having fun in the process and cherishing the environment. Their research project involves designing and building an energy-efficient vehicle that will be entered in the Shell Eco-marathon (SEM), which will take place from 21 to 24 May in Rotterdam next year.

"The Shell Eco-marathon challenges student teams world-wide to design, build and test vehicles that will travel further on less energy," says Dr Peter Jan Randewijk of the Department of Electrical and Electronic Engineering. "It is not about who drives fastest or who crosses the finishing line first. It is about better solutions for making transport more energy-efficient and simultaneously decreasing the impact on the environment."

The competition started in 1939, when employees of Shell in the USA made a friendly bet on who can drive furthest with the same amount of fuel. Since then it has extended to two other continents, Europe and Asia, and now also includes a variety of energy types, namely conventional petrol, diesel, biofuel, natural gas, hydrogen fuel cells and electrical batteries.

There are two classes in which to compete. In the *Prototype Class*, the focus is on maximum energy efficiency, with driver comfort taking a backseat, while the *Urban Concept Class* encourages more practical designs.

The dedicated Maties research team will participate as Team SUN and their car has been named *Inkonjane*, which means swallow in isi-Xhosa.

"Our battery-driven vehicle falls in the *Prototype Class* and will have two wheels at the front and one at the back. The vehicle's electrical drivetrain centres around an ironless, permanent magnet synchronous motor, which will be integrated with the power electronic converter in the hub of the rear carbon fibre disc-type wheel. The direct powering of the back wheel, without any mechanical linkage, aims to maximise the total efficiency of the drivetrain," explains Dr Randewijk.

"This ironless, permanent magnet synchronous motor stems from my PhD work with the first prototype built and tested by Gert Oosthuizen last year for his final-year project. This new motor is completely ironless, which implies that there are zero core losses as well as zero cogging torque. This results in a motor with extremely high efficiency. With the help of Innovus, we were able to preliminary patent the motor this year. This enabled us to obtain funding from the Technology Innovation Agency (TIA) for the further development and optimisation of the motor, which will form part of Gert's MEng. With the research project, we will also look at other possible applications of the electrical machine, for example for small wind generators, electrical bicycles, scooters, golf carts, etc.."

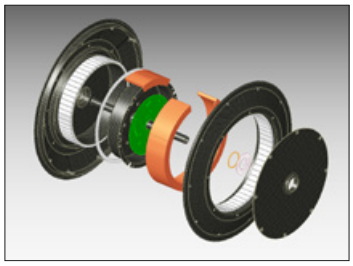
The SEM team, consisting of mechanical, mechatronic and electrical & electronic students and lecturers, was composed from enthusiastic and inspired members. Each team member plays an important role:

Gert Oosthuizen, MEng (Electrical)

Electrical direct-drive hub-motor

This is an extension of the double-rotor radial flux air-cored permanent magnet machine (DRFACPM). The magnet configuration on the double rotor was changed to a quasi-Halbach-array, thereby eliminating the need for a magnetic rotor back yoke, rendering the motor completely ironless. This new electrical motor was termed an ironless double-rotor radial flux permanent magnet motor (IDRFPM).

With the need for a magnetic rotor yoke eliminated, it was possible to design an IDRFPM motor with all the structural mechanical parts manufactured from carbon fibre composite material in order to produce a super lightweight electrical motor. Gert has designed a brand new direct-drive hub-motor incorporated into the rear disc-shaped carbon fibre 20" wheel. Preliminary calculations indicate an efficiency of 97% for the IDRFPM motor at a cruising speed of 25km/h on a flat track as would be the case for Rotterdam.



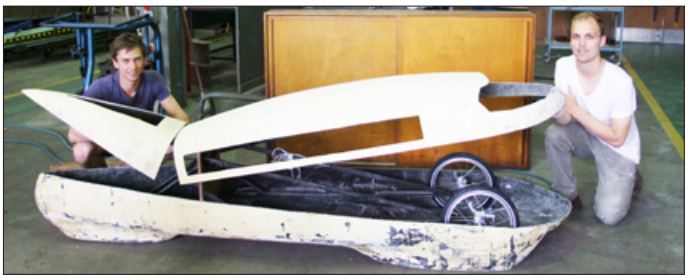
The exploded view of the hub-motor with integrated drive control.

Envisaged model of the final car as viewed from the front.

Felix Cranz, BEng (Mechanical)

Frame and steering mechanism

With the driver lying on her back, the steering mechanism was based on the same design used for the Engineering "Trapkarre" so as not to obscure the view through the front window. To reduce the weight, this was manufactured from lightweight, high strength 7075 aluminium. The front 16" wheels were also designed with a negative camber angle to reduce the wheel arches when turning and ultimately to reduce the frontal area of the car in order to produce a lower drag. A monocoque design was considered, but it was decided to use a lightweight carbon fibre frame to suspend the driver's seat and to distribute the driver's weight evenly between the front and rear axles. Felix was also responsible for the mechanical braking as well as looking into ways of reducing the rolling resistance of the car.



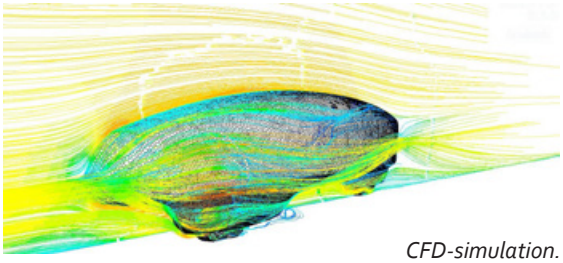
Progress so far: Tian van Tonder and Felix Cranz with the tear-drop-shaped, lightweight, high-strength, carbon fibre hull.

Christian Peters, BEng (Mechanical)

Aerodynamics

With the prototype being a three wheeler, it made it possible to design the hull to be as close as possible to the ideal "teardrop" form. The front wheels were placed inside the body of the car as this would enable an even lower drag coefficient.

The joint effort of Felix and Christian produced a combined frame and hull weight of only 18 kg, with an estimated weight of the total car around 35 kg. With a 50 kg-driver, this means the total weight would be approximately 85 kg. This resulted in a rolling resistance of approximately 0,0073 with the tyres currently used, although this could still be reduced even further by choosing better (and more expensive) tyres. The drag coefficient of the car was calculated at 0,0085 with the frontal area of the car at only 0,35m^2. These figures were confirmed by wind tunnel testing performed on a scale model. The final value for the car still has to be confirmed.

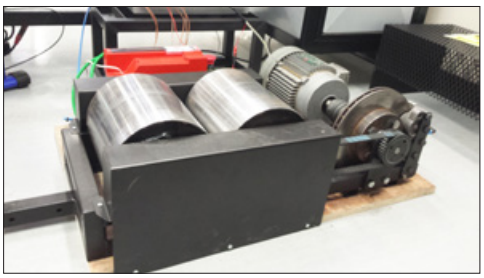


CFD-simulation.

More

Izandré Ras, BEng (Mechatronics)
Drivetrain specifications and driver interface
Izandré had to model and simulate the car, as well as the racetrack, in order to determine not only the maximum torque and speed specifications for the IDRFPM motor, but also the capacity in Ampère-hours of the Lithium-polymer (Li-poly) battery pack. Secondly, he had to design a driver information system to display the current speed, distance travelled, number of laps and time remaining to driver. Furthermore, he also had to record battery voltage and current, as well as the motor speed and torque via CANbus from the battery management system (BMS) and power electronic inverter respectively during the race. This "black box" data will enable the team to benchmark the car and track models together with the simulated results.

Tian van Tonder, BEng (Mechatronics)
Treadmill type track simulator
The idea is to put the prototype car on the treadmill simulator to evaluate the drivetrain system, before testing it on a real track. The track simulator will provide constant rolling resistance as well as an increased resistance applied to the wheels as the prototype car speeds up, to emulate the effect of drag versus speed of the car. It will also provide a convenient way of testing different control algorithms for the IDRFPM motor feedback loop in the convenience of the lab.



The treadmill track simulator.

Anton Treurnicht, BEng (Electrical & Electronic)
Power electronic motor drive controller
It was decided to place the power electronics inside the hub motor as there was enough retail space available. Although a position sensor was incorporated into the IDRFPM motor design, a sensorless control algorithm as a back-up was included, should the feedback sensor fail. MOSFETs with extremely low ON-resistance was also used in order to increase efficiency to the controller, but also to eliminate the need for a heatsink. The drive controller was programmed to allow for regenerative braking so as to convert the stored kinetic energy into electrical energy and charge the battery instead of using mechanical brakes where all the kinetic stored energy is dissipated as heat in the disc brakes.

Bartho Horn, BEng (Electrical & Electronic)
Li-poly battery management system
With each Li-poly cell measuring 3,7V, 13 cells in series are required to obtain a nominal battery voltage of 48V. Li-poly cells are very finicky and require good management to keep all the cell voltages balanced, especially during charging. Li-poly batteries have the bad reputation of catching on fire if they are not "managed" properly. The Li-poly cells also have a minimum voltage up to which they can be discharged as well as a maximum cell voltage up to which they can be charged. The BMS needs to disconnect the battery from the rest of the circuit immediately when either of these two voltage levels are reached. Li-poly cells also have a different "C-rating" for charging and discharging. The 5 500 mAh Li-poly cell used (weighing in at 1,5 kg), has a 1C charge rating, implying that the maximum charge current is 5,5A and a maximum discharge current of 2C, i.e. 11A. Although Anton's drive controller can be programmed to limit the battery current during acceleration and regenerative braking, the BMS has to provide additional security against a malfunction of the motor drive controller control algorithm.

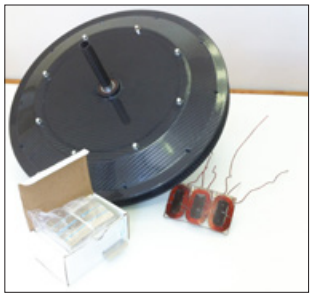
Tanweer Mahomed, BEng (Mechanical)
Driver
This driver is extra lightweight, weighing a mere x kg *.
(An extra 8 kg of ballasting has to be added to comply with the minimum driver weight of 50 kg.)
* You do not ask a lady her weight.

The two lecturers in the team, **Dr Peter Jan Randewijk (left) and Dr Danie Els (right),** respectively supervise the electrical & electronic, and the mechanical aspects of the project.

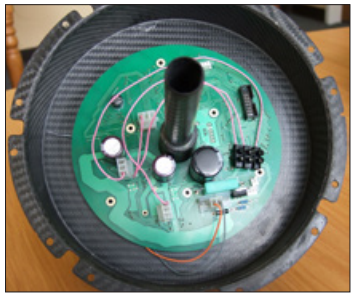
Martin Visser,
BComm (Actuarial Science)
Web & Twitter

Candice Murray,
BSc (Human Life)(Biol)
PR, advertising & sponsorships

Rentia Retief
BA (Fine Arts)
Inkonjane's body art/painting



The electrical direct-drive hub-motor with its permanent magnets and ironless stator coils.



The drive controller inside the hub-motor.

Dr Randewijk concludes: "This year 83 teams out of approximately 200 successfully completed the SEM Rotterdam event with 28 teams in the battery electric class. Each team is allowed five attempts. In at least one of these attempts they must successfully complete ten laps (covering a total distance of 16,117 km) within 39 minutes. This is the prerequisite for their result to be considered legal and valid to be taken into account for possible placement. This year the winning team for the Prototype battery electric class achieved 1091,6 km/kWh (that is less than 1 km per Wh).

"We thought it would be a good challenge to compete on an international stage especially in Europe and to benchmark Stellenbosch University against the best in Europe. Our long-term goals are to compete every year from 2015 onwards, depending on the sponsorships that can be attracted; to extend the multidisciplinary team to the industrial engineers; and to develop an optimal drive strategy that will enable the driver to receive real-time updates on the best driving strategy to follow whilst driving.

"We have been successful for Phase I of the registration for the Shell Eco-marathon Europe 2015. During Phase II the technical details of our car will be evaluated. May our superlight swallow soar!"

Contact:
Dr Peter Jan Randewijk
Department of Electrical and Electronic Engineering
Stellenbosch University
pjrandew@sun.ac.za
http://www0.sun.ac.za/teamsun/

Fakulteitsnuus/Faculty News

ECSA accredits all six BEng programmes fully until 2018

At the end of June 2014 the Faculty received the good news that all six of the Faculty's BEng programmes have been fully accredited until the end of 2018, without any deficiency.

During August 2013 the Engineering Council of South Africa visited the Faculty of Engineering for the normal five-yearly accreditation of the Faculty's six BEng programmes. An accredited BEng degree is a prerequisite for registration as a Professional Engineer after acquiring the relevant experience in practice.

The ECSA team that visited the Faculty initially identified a deficiency in one of the BEng programmes. However, after an appeal process it was found that there was no deficiency.

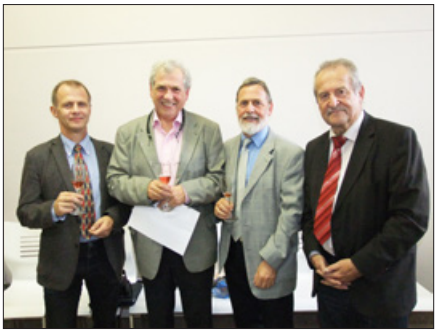
The six programmes that have been fully accredited are BEng (Chemical), BEng (Civil), BEng (Electrical and Electronic), BEng (Industrial), BEng (Mechanical), and BEng (Mechatronic).

This is indeed an achievement (and unique within the current ECSA accreditation process) that for the second consecutive accreditation visit all the Faculty's BEng programmes have been fully accredited (without any deficiency) for the full five-year term.

ECSA is part of the *Washington Accord*. Consequently, for professional purposes Stellenbosch University's BEng degrees are therefore also recognised in countries signatory to the *Washington Accord* (e.g. Australia, Canada, New Zealand, United Kingdom, United States of America, etc.)

Each and every student and alumnus can therefore be assured that the BEng degree he/she obtains or obtained is regarded highly worldwide.

Prof Dimitrov honoured



Prof Diminti Dimitrov (second from the left) with his industrial collaborators from Germany, Profs Lutz Lachman, Jochen Dietrich and Detlef Kochan at the function held in Prof Dimitrov's honour.

On 3 November 2014 the Department of Industrial Engineering honoured Prof Dimitri Dimitrov for his excellent contribution in the field of rapid product development over the last 15 years. During this festive occasion Prof Dimitrov thanked several groups of people who had played a role in his life, such as the Chairs of the Department of Industrial Engineering, faculty management, colleagues, Research and Developement staff, industry, collaborators, students, and administrative staff.

Dr Tiaan Oosthuizen (left) succeeds Prof Dimitrov, his mentor, as head of the Rapid Product Development Laboratory.

Adviesraad byeen

Die jaarlikse byeenkoms van die Fakulteit Ingenieurswese se Adviesraad het op 27 Oktober plaasgevind. Ná 'n aanbieding deur die dekaan, prof Hansie Knoetze, oor die stand van sake in die Fakulteit en 'n oorsig oor die US se Institusionele Voorneme en Strategie, het Raadslede en Fakulteitspersoneel dit in die onderskeie Departemente bespreek.

Na goeie gesprekke in die Departement Siviele Ingenieurswese, ontspan Christoff Krogscheepers (ITS) saam met dr Celeste Barnardo-Viljoen en prof Billy Boshoff.

Die Bedryfsingenieurswese span - Voor prof Corne Schutte en Adriaan Scheeres (Pragma). Middel Stephen Bosman (Melrose Atteridge), Michelle Cilliers (Cillutions) en dr Steve Minnaar (Abax Investments). Agter Wilhelm Boshoff (LTS Consulting) en Gerrit Kotze (Sasol).

In Memoriam

The Department of Process Engineering was shocked and deeply saddened by the sudden passing of Dr Denise Venter on 16 August 2014, as a result of a cycling accident.

She obtained her BEng (Chemical) in 1995 and passed no less than 16 of her subjects with distinction. She then pursued a master's degree under the supervision of Prof Izak Nieuwoudt and obtained MScEng *cum laude* in 1997. She continued her postgraduate studies and obtained a doctoral degree in March 2001, again under the supervision of Prof Nieuwoudt with the thesis entitled *The separation of phenolic compounds from neutral oils and nitrogen bases*. Her doctoral studies contributed significantly towards the development of a separation process implemented at Sasol.

The late Dr Denise Venter.

Dr Venter was one of the first two female students to obtain her doctoral degree in Chemical Engineering from Stellenbosch University and the first female student to be awarded a bachelor's, master's and doctoral degree, all from this Department.

Upon completion of her doctoral studies, she spent a year as a post-doctoral researcher/part-time lecturer where she assisted in teaching thermodynamics and separation processes.

From Janaury 2002 she was employed at Sasol Technology in their Separations group. Here she has played a vital role in many strategic projects. Dr Venter was a brilliant engineer and an excellent ambassador for Stellenbosch University in general and the Department of Process Engineering in particular. In her understated manner she quietly went about tasks delivering excellent work time and time again.

Since leaving Stellenbosch at the end of 2001, she has remained in contact with the Department of Process Engineering. She has assisted the Department on many an occasion while acting as external examiner, both at undergraduate and postgraduate level. In this voluntary role, she delivered excellent, faultless work.

Since starting her studies at the Department, Dr Denise Venter was a well-loved member of our chemical engineering family. She was a humble, kind, unselfish and caring person with a deep love for nature. She leaves behind a large gap in the lives of many of our current and previous students and staff members and will be sorely missed by all.