Department of Chemical Engineering

Annual Report 2015

Department of Chemical Engineering

Private Bag X3

Rondebosch

7701

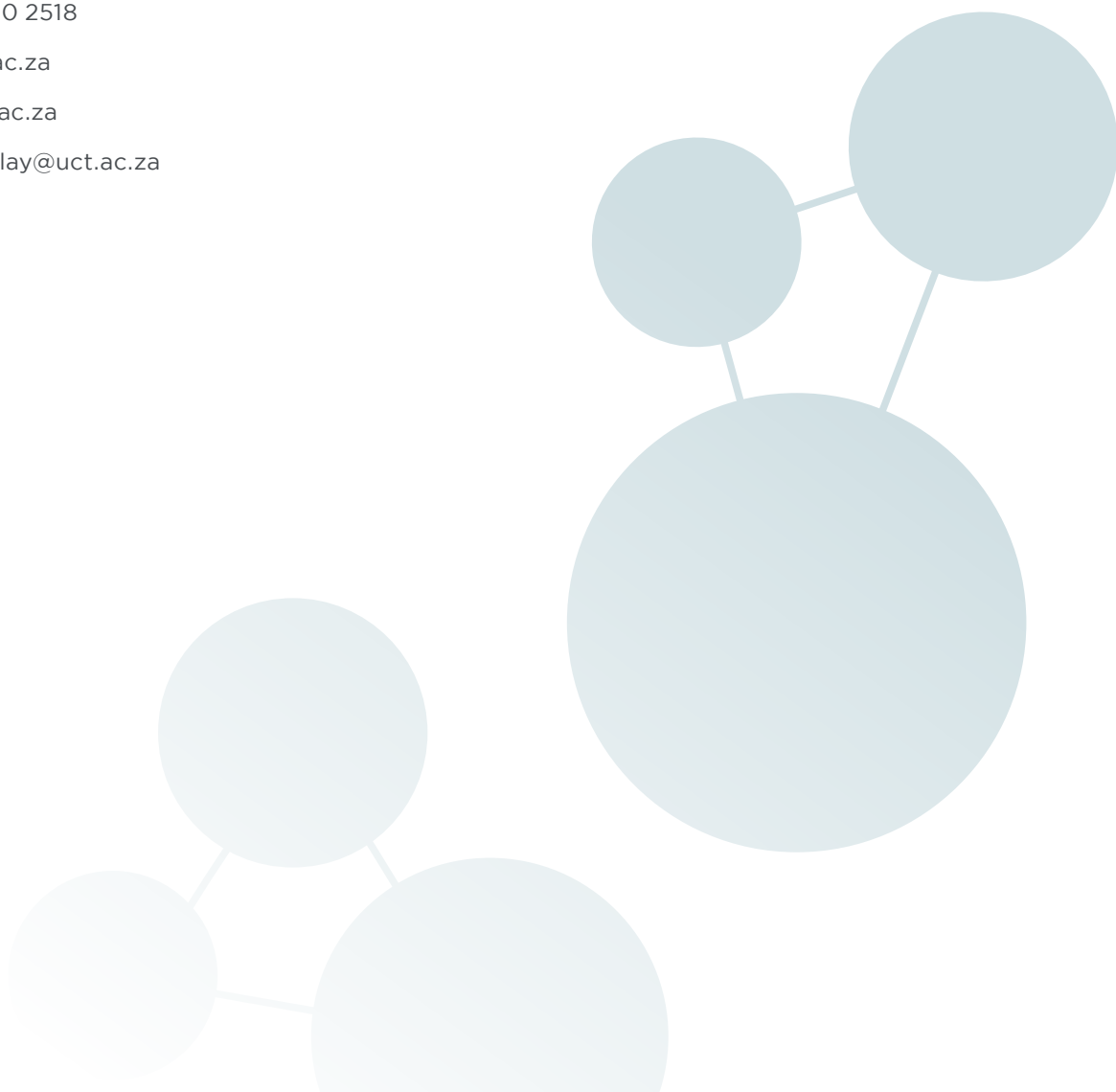
South Africa

Telephone: (021) 650 2518

Website: www.uct.ac.za

www.chemeng.uct.ac.za

Contact: Sarojini.Pillay@uct.ac.za



History of Chemical Engineering

The Chemical Engineering Department is located on the historic Upper Campus of the University of Cape Town, on the southern slopes of Table Mountain's Devil's Peak. The Campus is adjacent to the Table Mountain National Park, part of the Cape Floral Region, which has been declared a UNESCO World Heritage Site.

The first home of the Chemical Engineering Department, built in 1969 to house only six academics, 12 postgraduates and an annual intake of 30 undergraduates, was the building that is now called Hoerikwaggo. Despite continuous building modifications (and eventually even a few Zozo huts erected in the parking lot), the increased number of students, coupled with a substantial increase in research activity, meant that the building was no longer adequate.

Thus, in 2004, the Department relocated to the much larger and newly built New Chemical Engineering Building. At that time, the prediction was that the Department's annual intake would grow by five percent, and that there would be 450 undergraduates and 130 postgraduates in the programme within ten years (by 2014). These figures were already exceeded by 2013. The New Chemical Engineering Building itself has won an Award of Merit from the South African Institute of Architects for its design.

In 2013, in response to continued growth in both the undergraduate and the postgraduate programmes, the Department expanded still further and we now also share parts of the New Engineering Building with the Civil Engineering Department, the Faculty Office and the new Centre for Imaging and Analysis. Our undergraduate body has grown to such an extent that most teaching takes place nowadays in the new Snape Teaching and Learning Facility.

Contents

Photography
Candice Mazzolini

Foreword

The year 2015 was challenging for universities in South Africa owing to the national student protest actions. The University of Cape Town, including the Department of Chemical Engineering, faced unforeseen challenges due to both the protest action and the unprecedented closure of the campus.

Head of Department, Professor Eric van Steen

Despite these challenges, the university achieved full closure of its 2015 academic year. In Chemical Engineering, 96 students obtained BSc(Eng) degrees in Chemical Engineering of which 24 were with first class honours and 33 with honours. At the postgraduate level, 44 were awarded MSc(Eng) and MPhil degrees and six the PhD degree. At the undergraduate level, the roll-out of the new BSc(Eng)(Chemical Engineering) curriculum continued with implementation of the new whole year course for our 2nd year students. The implementation is the result of several years of intensive preparation to address the needs of the student body while maintaining the quality of our graduates. The new 2nd year course uses chemical engineering design as a teaching vehicle to exemplify theoretical concepts which are taught in short blocks. The course aims to build an integrated approach to thinking and engineering principles from the start of the program. Strands, such as process economics, environmental aspects, communication and process safety, are taught along the more classical theoretical aspects.

The strong research focus in the Department underpins the postgraduate programs offered, which are thriving. Soft-funded staff, i.e. staff dependent on research income are a vibrant part of this research and postgraduate activity. There are currently 184 postgraduate students within the Department, linked to the research groupings in bioprocess engineering, catalysis, crystallization and precipitation, engineering education, environmental process engineering, hydrometallurgy, minerals processing, process modelling and related inter and trans disciplinary initiatives.

The Department welcomed two new members of staff occupying SARChI chairs. Professor Patricia Kooyman, the SARChI chair in Nanomaterials for Catalysis associated with the DST-NRF Centre of Excellence in catalysis, c*change joined us from the Technical University of Delft. The Department welcomed Professor Dee Bradshaw back from the University of Queensland, to take up the SARChI chair in Minerals Beneficiation from the start of 2016. The chair became vacant upon the retirement of Professor J-P Franzidis. With Prof Alison Lewis becoming Dean of the Faculty of Engineering and the Built Environment, the Department filled two vacant permanent posts and welcomed Dr Marijke Fagan-Endres and Ms Tokoloho Rampai.

Brian Paddon

(1932 – 2015)

Emeritus Associate Professor Brian Paddon passed away on 20 June 2015, having been an academic in the Department of Chemical Engineering from 1969 until his retirement in 1994.

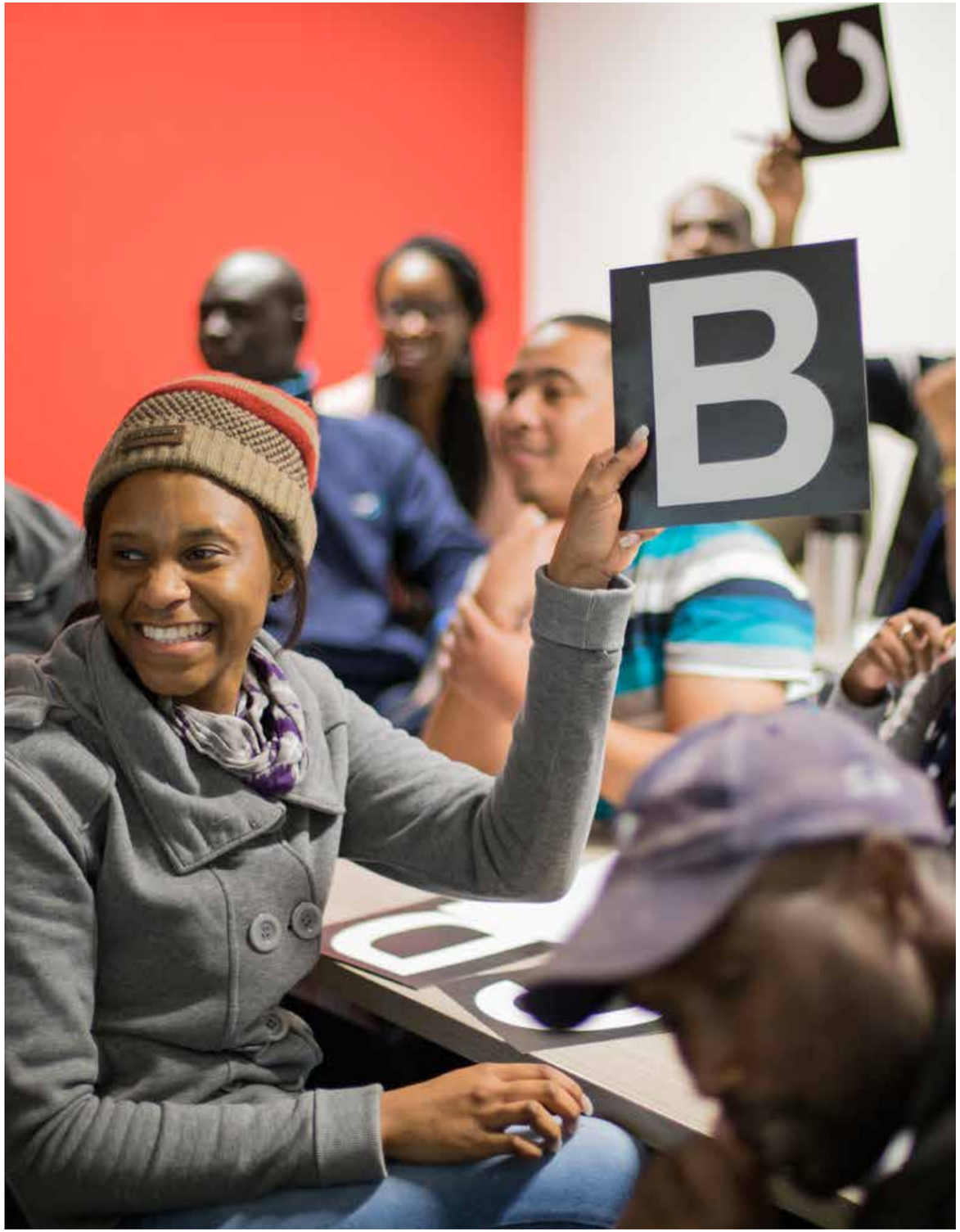
Brian was born in Calcutta, India, in 1932 and spent his early childhood in Amritsar, attending school in Darjeeling. During World War II, he and his sister were sent back to South Africa, and Brian matriculated from St Andrew's College in Grahamstown in 1950. He went on to UCT, where he graduated with a degree in applied and industrial chemistry (shortly thereafter to become chemical engineering). His first job was at the Mobil refinery in Durban, where he was involved in the early development of Mobil's first fluidised catalytic cracking unit.

He returned to Cape Town in 1963, continuing to work with Mobil; and during that time completed his MBA as one of the first graduates from UCT's Graduate School of Business. In 1969 Brian left the corporate world for a position in the Department of Chemical Engineering at UCT, joining other luminaries from the early days of chemical engineering such as the late Donald Carr and Heinrich Buhr. The Department in those days was small, with only a handful of lecturers, and graduating classes of between 10 and 20. However, Brian and his colleagues created a wonderful foundation for what is today widely regarded as one of the leading Departments of Chemical Engineering globally.

The Department benefited greatly from having someone on its lecturing staff with such extensive industrial experience, and Brian became renowned as the convener of the tough Design Course – the capping course to the chemical engineering degree. His knowledge of chemical engineering processes was legendary, and through this he made an enormously positive impact on generations of chemical engineering students. Brian, ever cheerful and pleasant to all and sundry, was passionate about his

teaching and will be fondly remembered by colleagues not only in the Department of Chemical Engineering, but also in all the Engineering Departments at UCT. Staff and students will recall how wonderfully helpful he was to students struggling with the basics of chemical engineering, and to new young academics still finding their feet.

The university and the Department of Chemical Engineering, in particular, are deeply indebted to Brian for his dedicated and passionate contributions to the Department over almost three decades, and all those with whom he came into contact will long remember him.

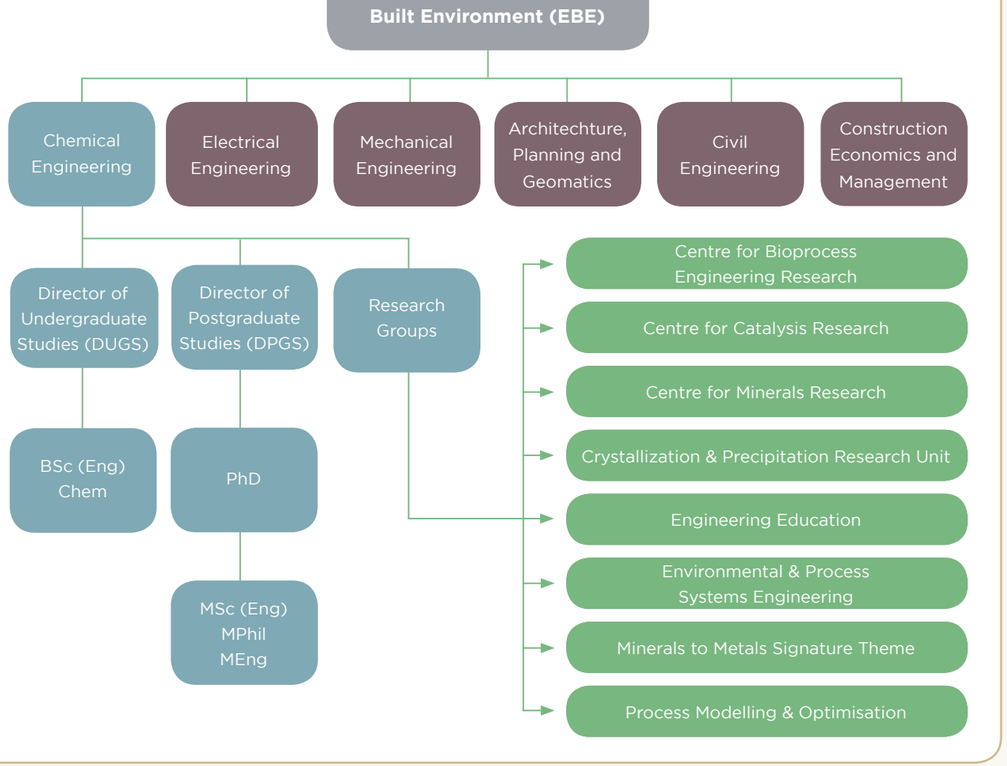


MinQuiz - South Africa's premier national science competition

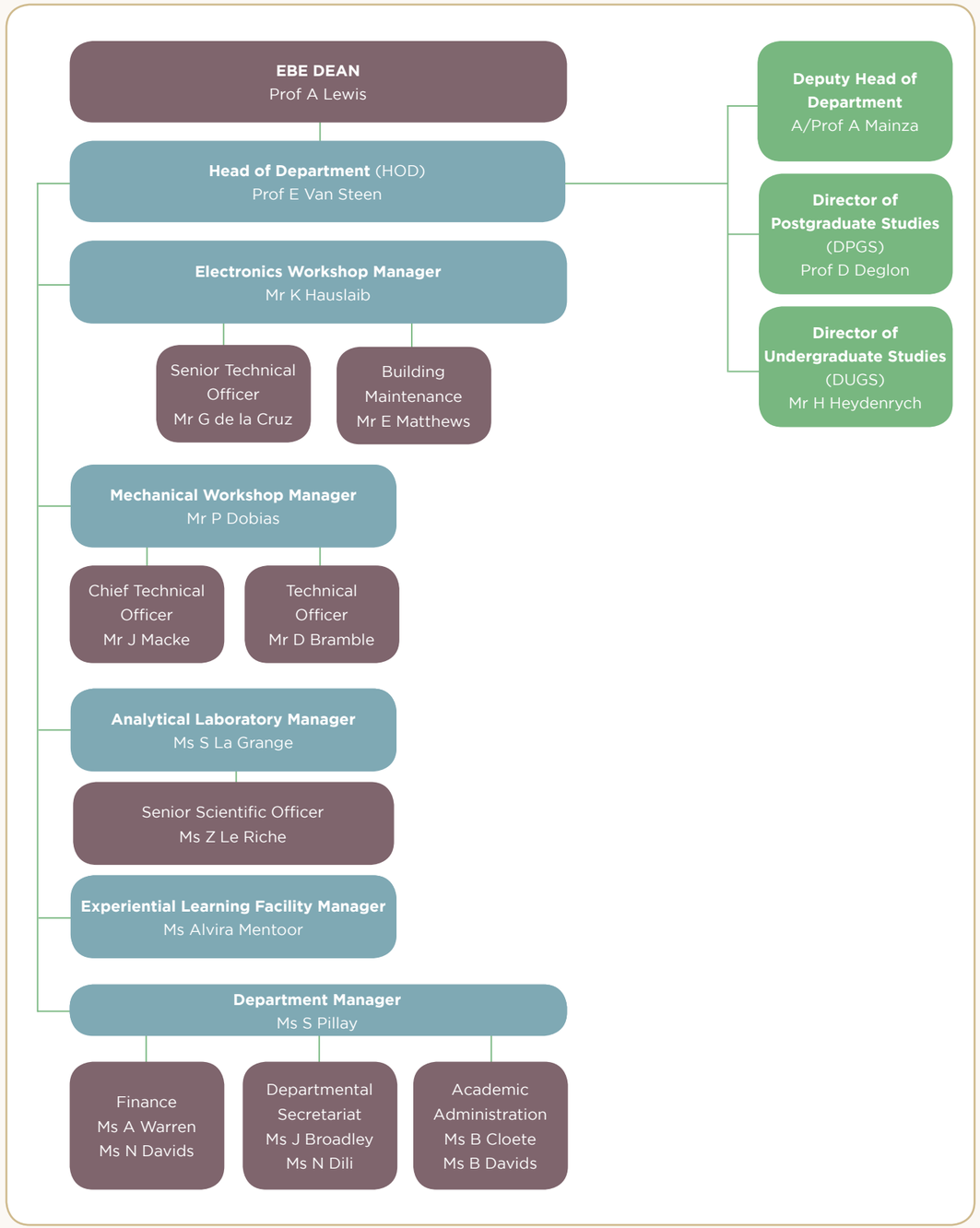
Department profile

The Department of Chemical Engineering at UCT is one of six Departments in the Faculty of Engineering & the Built Environment; the others being the Departments of Civil, Electrical and Mechanical Engineering; the Department of Architecture, Planning and Geomatics; and the Department of Construction Economics and Management.

The Department offers a four year BSc (Chem Eng), as well as master's and doctoral degrees. The MSc (Chem Eng), MPhil, and the PhD may all be pursued by dissertation only. There is also an option to pursue the MSc (Chem Eng), and MPhil by a combination of structured coursework and dissertation (60 credits coursework and 120 credit dissertation). The Department also has strong and growing research activity, as evidenced by the number of university accredited research groupings hosted by the Department, as well the large number of registered postgraduate students.



Technical, scientific and administration profile



Staff in research groups

Research group	Academic staff and research officers	Scientific and technical staff	Managerial, administrative and support staff
Centre for Bioprocess Engineering Research (CeBER)	**Prof STL Harrison**	Mr T Samkange	Ms S Jobson
	A/Prof J Petersen	Mr T Goleka	Ms S Christian
	Dr M Fagan-Endres	Ms J Hitchcock	Ms C Mazzolini
	Dr C Fenner	Ms L Hanise	Ms L Mostert
	Dr R Huddy	Mr I Ngoma	
	Dr M Johnstone-Robertson	Ms S Rademeyer	
	Dr S Tai		
Centre for Catalysis Research (CAT)	**Prof J Fletcher**	Ms R Cupido	Ms L-A Kallam
	Prof M Claeys	Mr G Kaufmann	Dr R Weber
	Prof P Kooyman	Mr W Koorts	Ms E Williams
	Prof E van Steen	Ms C Le Roux	Mr S Roberts
	Dr S Blair	Mr D Reyskens	
	Dr R Brosius	Ms T Khosa	
	Dr J Chamier	Mr Y Zhou	
	Dr N Fischer	Mr M Wust	
	Dr P Levecque		
	Dr S Tanaka		
	Ms N Abbas		
	Mr W Böhringer		
	Mr N Hussain		
	Mr N Lüchters		
Crystallization & Precipitation Research Unit (CPU)	**Prof A Lewis**	Dr T-A Craig	Ms H Battle
	Dr M Rodrigues-Pascal	Mr J Chivavava	Ms L-A Kallam
	Mr H Heydenrych	Mr M Kapembwa	
Centre for Minerals Research (CMR)	**Prof D Deglon**	Mr M Bekhapi	Ms H Sundstrom
	Emeritus Prof C O'Connor	Mr D de Klerk	Ms N Davies
	A/Prof A Mainza	Mr G Edwards	Ms C Pomario
	Dr M Becker	Mr S Geldenhuys	
	Dr L Bbosa	Ms S Govender	
	Dr K Corin	Mr G Groenmeyer	
	Dr I Govender	Mr M Lisso	
	Dr B McFadzean	Mr K Maseko	

Research group	Academic staff and research officers	Scientific and technical staff	Managerial, administrative and support staff
	Dr G Tupper	Ms L Nkemba	
	Mr P Bepswa	Mr R van Schalkwyk	
	Mr M Harris	Ms R Moalosi	
	Mr A Mabentsela	Ms G Yorath	
	Ms T Rampai		
	Ms J Sweet		
	Mr A van der Westhuizen		
	Mr J Waters		
	Ms J Wiesec		
Centre for Research in Engineering Education (CREE)	**Prof J Case**		Ms C Carr
	Mr H Heydenrych		
Environmental & Process Systems Engineering (E&PSE)	**Prof H von Blottnitz**		Ms C Carr
	Dr A Isafiade		
	Honorary Prof J Petrie		
	Adjunct A/Prof P Notten		
Minerals to Metals Initiative (MtM)	**A/Prof J Petersen (Acting Director SARChI chair)**		Ms E Jacobs
	Prof D Bradshaw (appointed 2016)		
	Prof DA Deglon		
	Prof STL Harrison		
	Prof A Lewis		
	Prof H von Blottnitz		
	A/Prof A Mainza		
	Dr M Becker		
	Dr J Broadhurst (Acting Director)		
	Dr A Isafiade		
Process Modelling & Optimisation	**Prof K Möller**		

Technical, scientific and administrative staff

Electronics Workshop

Mr K Hauslaib, Chief Technical Officer

Mr G De la Cruz, Senior Technical Officer

Mr E Matthews, Building Supervisor

Mechanical Workshop

Mr P Dobias, Principal Technical Officer

Mr J Macke, Chief Technical Officer

Mr D Bramble, Technical Officer

Analytical Laboratory

Ms S La Grange, Chief Scientific Officer

Ms Z Le Riche, Senior Scientific Officer

Experiential Learning Facility

Ms A Mentoor, Chief Scientific Officer

Department Administration

Ms S Pillay, Department Manager

Ms B Cloete, Undergraduate Administrative Officer

Ms B Davids, Postgraduate Administrative Officer

Ms A Warrin, Finance Assistant

Ms N Davids, Finance Assistant

Ms J Broadley, Secretary

Ms N Dili, Department Secretary

Mr G Inggs, Unix Administrator

Academic staff and research fields

Name	Research field
Ms Naseeba Abbas	Centre for Catalysis Research – Investigation of non-carbon support materials for platinum electrocatalysts in polymer electrolyte fuel cells
Dr Lawrence Bbosa	Centre for Minerals Research – Ore breakage, numerical simulation techniques such as the Discrete Element Method (DEM) for simulation of comminution devices; validation through experimental techniques such as Positron Emission Particle Tracking (PEPT)
Mr Paul Bepswa	Centre for Minerals Research – Metal accounting, comminution
Dr Megan Becker	Centre for Minerals Research – Process mineralogy – practical study of minerals associated with the processing of ores, concentrates and smelter products for the development and optimisation of metallurgical flow sheets
Dr Sharon Blair	Centre for Catalysis Research – Director of HySA/Catalysis – Technology transfer
Mr Walter Böhringer	Centre for Catalysis Research – Acid catalysis
Dr Jennifer Broadhurst	Minerals to Metals Signature Theme – Inter-disciplinary approaches to the responsible and sustainable development of mineral resources, effective management of mine wastes and primary metal processing residues
Dr Roald Brosius	Centre for Catalysis Research – Diesel selective and gasoline/ kerosene selective catalytic synthetic fuel processes; noble metal promoted zeolite catalysts for Fischer-Tropsch compatible hydrocracking catalysts; hierarchically and/or nano-structured zeolite catalysts for combined FT synthesis and fuels upgrading in micro-channel and continuously stirred tank reactors
Prof Jenni Case	Engineering Education Research – Higher education with a focus on science and engineering programmes, South African higher education and academic development, student learning in university, contemporary pedagogical and curricular innovation, race, class and gender in higher education, sociology of knowledge, research methods and methodology
Dr Jessica Chamier	Centre for Catalysis Research - Materials scientist developing and synthesising new materials for membrane electrode assemblies (MEAs) used in fuel cell design. Focusing on the design, development and electrocatalytic evaluation of novel catalyst support materials, as well as methods for catalyst deposition and impregnation.
Prof Michael Claeys	Centre for Catalysis Research – Director of the DST/NRF Centre of Excellence in Catalysis (c*change), Fischer-Tropsch synthesis, in-situ catalyst characterisation, nano-materials
Dr Kirsten Corin	Centre for Minerals Research – Flotation chemistry

Name	Research field
Prof David Deglon	Anglo American Platinum Chair in Minerals Processing and Director of the Centre for Minerals Research – Computational fluid dynamics and flotation cell modelling; conventional mechanical flotation cells and novel flotation cells; particle-bubble contacting in turbulent multi-phase flow environments, with the emphasis on fine particles; use of computational methods for modelling fluid flow and an understanding of non-Newtonian slurry rheology
Dr Marijke Fagan-Endres	Centre for Bioprocess Engineering Research – Heap bioleaching; bioflotation; biological isothermal micro-calorimetry; MRI and X-ray CT
Dr Caryn Fenner	Centre for Bioprocess Engineering Research – Production of affordable, modern fine chemicals and commodity bioproducts, product optimisation, and induction; production of industrial enzymes with commercial applications; environmental sustainability of biocatalytic processes, cascade reactions with respect to green chemistry and the development and optimisation of bio-analytical techniques
Dr Nico Fischer	Centre for Catalysis Research –DST/NRF Centre of Excellence in Catalysis (c*change), heterogeneous catalysed synthesis gas conversion reactions. Development and application of in-situ material catalyst characterisation techniques
Prof Jack Fletcher	Director of the Centre for Catalysis Research and Contract Director of National Hydrogen Catalysis Competence Centre (HySA/Catalysis) – Catalysis by noble metals, zeolite catalysed conversion of phenol and derivatives, wax hydrocracking, shape selectivity in zeolites and molecular sieves, hydrogen processors, and fuel cells
Mr Martin Harris	Centre for Minerals Research – Flotation circuit modelling
Prof Sue Harrison	SA Research Chair in Bioprocess Engineering and Director of the Centre for Bioprocess Engineering Research – Interaction of micro-organisms with the environment; microbial ecology, community dynamics and structure-function relationships, biofilms and cell retention; energy efficient reactor systems; biokinetics, modelling of biomass, bioproducts and integrated bioprocess systems. The above is applied to the fields of: alkane biotechnology, biomanufacture of pigments, enzymes and nutraceuticals, yeast handling, biohydrometallurgy through heap and tank processes, acid rock drainage (ARD) prevention, ARD and minewater bioremediation, wastewater bioprocessing, algal bioprocesses for bioenergy and fine chemicals, bioprocess design, industrial ecology and evaluation for sustainable process engineering

Name	Research field
Mr Hilton Heydenrych	Crystallization and Precipitation Research Unit – Development of a systematic approach for the treatment of effluent water streams using multi-criteria evaluations and comparisons of simulated processes to develop new heuristic principles for the design of water treatment processes; chemical engineering education-curriculum design and the analysis of throughput issues
Dr Robert Huddy	Centre for Bioprocess Engineering Research – Microbiology, molecular biology, metagenomics, biological isothermal micro-calorimetry; mineral biotechnology; microbial ecology, biological sulphate reduction, bioremediation of thiocyanate contaminated wastewater effluent
Mr Nabeel Hussain	Centre for Catalysis Research – Design and development of catalytic components and devices for low temperature fuel cells
Dr Adeniyi Isafiade	Environmental and Process Systems Engineering – Process design and optimisation
Dr Madelyn Johnstone-Robertson	Centre for Bioprocess Engineering Research – Enzyme production, wastewater biorefineries, biopolymer production, integrated bioprocess development, fungal pigments, bioreactor technology, anaerobic digestion (AD)
Prof Patricia Kooyman	SA Research Chair in Nanomaterials for Catalysis, Centre for Catalysis Research – Nanomaterials synthesis and characterisation, electron microscopy
Dr Pieter Levecque	Centre for Catalysis Research – Electrocatalysts for fuel cells and high throughput catalyst preparation
Prof Alison Lewis	Director of the Crystallization and Precipitation Research Unit – Industrial precipitation and crystallization, recovery of value from effluent streams, water treatment through crystallization, Eutectic Freeze Crystallization, product and particle analysis; process analysis and control for optimised product quality; crystallization process development; aqueous chemistry modelling of speciation, thermodynamic equilibria, hydrodynamic and population balance modelling of precipitation systems
Mr Niels Lüchters	Centre for Catalysis Research – High throughput experimentation, parallel preparation of heterogeneous catalysts, high throughput methodology for fuel processing research
Mr Arthur Mabentsela	Centre for Minerals Research – Numerical and physical modelling of pyrometalurgical operations
A/Prof Aubrey Mainza	Centre for Minerals Research – Comminution, classification, CFD/DEM modelling, PEPT
Dr Belinda McFadzean	Centre for Minerals Research – Flotation chemistry

Name	Research field
Prof Klaus Möller	Process Modelling and Optimisation – Multiphase reactor modelling, separator modelling, integrated reaction – separation systems modelling, parameter estimation, modular process and flowsheet feasibility and optimisation. Centre for Catalysis Research – wax hydrocracking modelling, FT process modelling
A/Prof Jochen Petersen	Centre for Bioprocess Engineering Research – Hydrometallurgy, especially heap (bio) leaching of low grade minerals, heap reactor characterisation and modelling, hydrometallurgical process analysis, leaching kinetics in ammonia and cyanide systems, bioleaching processes
Ms Tokoloho Rampai	Centre for Minerals Research – Carbide MAX phases composites with cubic boron nitride ceramics, pyrometallurgy
Ms Jeanette Sweet	Centre for Minerals Research – Comminution circuit optimisation and design, flotation circuit optimisation, technology transfer
Dr Siew Tai	Centre for Bioprocess Engineering Research – High-value bioproducts, vaccines and biopharmaceuticals; bioreactor design, cell culture in bioreactors; beer and wine fermentation; metabolic engineering, systems biology, bioenergy
Dr Shiro Tanaka	Centre for Catalysis Research – Systems development, product development and materials science, mechanical engineering, software development and computational fluid dynamics, business development, Technical marketing
Mr Andre van der Westhuizen	Centre for Minerals Research – Comminution and fine particle processing
Prof Eric van Steen	Centre for Catalysis Research/DST-NRF Centre of Excellence in Catalysis c*change – Fischer-Tropsch synthesis, nano-materials, molecular modelling of heterogeneous catalytic systems, reaction kinetics
Prof Harro von Blottnitz	Environmental and Process Systems Engineering – Industrial ecology, life cycle assessment, material flow analysis, recycling systems, organic waste valorisation with a focus on biogas, all applied to questions of resource-efficient and clean production, also in informal settings; Engineering education for sustainable development; sustainable mineral resource development
Mr Jason Waters	Centre for Minerals Research – Comminution and classification optimisation, and slurry rheology
Ms Jennifer Wiese	Centre for Minerals Research – Flotation Chemistry

Emeritus, honorary and adjunct staff	
Emeritus Professor	
Cyril O'Connor	Centre for Minerals Research – Flotation chemistry
Honorary Professor	
Dee Bradshaw	Centre for Minerals Research – Flotation chemistry
Michael J Nicol	Hydrometallurgy research
Jim Petrie	Environmental and Process Systems Engineering – Decision support systems, sustainable energy systems, industrial ecology
Honorary Research Associate	
Chris Bryan	Centre for Bioprocess Engineering – Mineral bioleaching through tank and heap processes, biohydrometallurgy of electronic waste, mine waste handling
Melinda Griffiths	Centre for Bioprocess Engineering Research - Process improvements and economics of large scale production of Spirulina and other micro algae
Wynand Andre Van Dyk	Risk management, process optimisation and project management
Melissa Anne Petersen	Centre for Catalysis Research, HySA/Catalysis – Molecular modelling of catalytic systems
Rob van Hille	Centre for Bioprocess Engineering Research – Mineral biotechnology, algal biotechnology, sulphide chemistry and bioremediation, acid mine drainage retention treatment, anaerobic digestion
Christopher Dennis Woolard	Fuels research, Sasol Advanced Fuels Laboratory
Adjunct Professor	
Paul Dempsy	Chemical Engineering design
Sandy Lambert Field	Centre for Minerals Research
Jeremy Wilson Mann	Centre for Minerals Research
David Wright	Chemical Engineering, strategy, internal and external review, curriculum, design
Adjunct Associate	
Philippa Notten	Environmental and Process Systems Engineering – Life Cycle Assessment (LCA)

Postdoctoral Fellows	
Dr Muhammad Ashraf	Centre for Catalysis Research, HySA/Catalysis – Fuel processing
Dr Sundaram Babu	Centre for Catalysis Research, HySA/Catalysis – Fischer Tropsch synthesis
Dr Palesa Diale	Centre for Bioprocess Engineering Research – Water pollution control and remediation of acid mine drainage. Use of microalgae for metal removal
Dr Juarez Amaral Filho	Centre for Bioprocess Engineering Research – Environmental issues related to processing, discard and disposal of mineral wastes and effluents; effective management, processing, characterisation and use of mineral wastes; mine water reuse and recycling; acid rock drainage prediction, evaluation, minimisation, mitigation and downstream uses
Dr Jack V. Fletcher	Centre for Catalysis Research, HySA/Catalysis – Micro-channel reactors
Dr Marc Fürst	Centre for Catalysis Research – Detailed analysis of iron-based Fischer-Tropsch product using GCxGC chromatography
Dr Elaine Govender	Centre for Bioprocess Engineering Research – Application and optimisation of mineral (bio) leaching processes in heap systems, with focus on mineral-microbe interaction and the modelling of microbial transport facilitated through solution flow dynamics. Application of bioprocess engineering principles in the treatment of waste electronic and electrical equipment (WEEE) for value recovery
Dr Athanasios Kotsiopoulos	Centre for Bioprocess Engineering Research – Liquid-mineral contacting for the optimisation of heap leaching and prevention of acid rock drainage
Dr Hendrik Kotze	Centre for Catalysis Research, DST-NRF Centre of Excellence in Catalysis c*change – Magnetic and Raman analysis of working Fischer-Tropsch catalysts
Dr Tobias Louw	Centre for Bioprocess Engineering Research – Multi-scale mathematical modelling of algae raceway ponds for optimal mass transfer and energy usage
Dr Doreen Nabaho	Centre for Catalysis Research, DST-NRF Centre of Excellence in Catalysis c*change – Fischer-Tropsch synthesis
Dr Robert Pott	Centre for Bioprocess Engineering Research – Conversion of waste organics into hydrogen, electricity and high value products by wild-type and genetically modified Rhodopseudomonas palustris
Dr Rahul Ram	Minerals to Metals Signature Theme – hydrometallurgy, minerals characterisation, understanding the effects of nano pore spaces on leaching of large ore particles
Dr Valentina Russo	Environmental and Process Systems Engineering – LCA for the quantification of environmental impact reductions provided by biogas installations incorporated in the meat production value chain
Dr Bernhard Schwanitz	Centre for Catalysis Research, HYSA/Catalysis – Development of bimetallic precious metal catalysts for steam reforming of methane and Advanced MEA fabrication methods
Dr Mariette Smart	Centre for Bioprocess Engineering Research – Selection and characterisation of CO_2 sequestering algal strains for carbon mitigation of coal-derived flue gas and waste water remediation at power production plants. Microbial ecology in mixed microbial processes
Dr Margreth Tadie	Centre for Minerals Research – Flotation chemistry, electrochemistry. Investigation of the effect of Eh on recovery of sulphide minerals

Facilities and equipment in the Department of Chemical Engineering

The Department of Chemical Engineering runs an Analytical Laboratory, a Mechanical Workshop and an Electronics Workshop.

Analytical Laboratory

The Analytical Laboratory has a range of expertise and facilities for elemental analysis and particle characterisation of solid and liquid samples. The facilities include equipment such as XRF, AAS, and ICP-OES for elemental analysis and Malvern Mastersizer for particle size and distribution analysis. The properties of sample surfaces are determined using a combination of equipment, such as the zetasizer, BET and chemisorption.

Departmental facilities

Within the Chemical Engineering Department liquid and gas chromatography is performed using various detection methods such as UV/VIS or RID for liquid chromatography, FID, TCD or MS-detection for gas chromatography. Furthermore, two dimensional GC analysis is performed using GCxGC with TOF-MS.

In addition, the Department has some unique equipment in the form of an in-situ magnetometer (for measurement of content of magnetic material present under high temperature and high pressure conditions) and a novel in-situ XRD set-up (for monitoring in-situ transformations within solid materials at elevated temperatures and pressures).

A variety of reactors are available within the Department for testing biological reactions (fermenter, air-lift reactor), heterogeneously catalysed reactions (fixed bed reactors, slurry reactors, Berty reactor), catalyst for fuel cells (fuel cell stations), crystallization processes (Eutectic Freeze Crystallizers and LabMax crystallizers) and precipitation reactions (multiphase stirred tank reactors, fluidised bed crystallisers and large scale (100L) multiphase reactors).

Electronics Workshop

The Electronics Workshop provides technical support to research groups and postgraduate students in the field of electronics, embedded systems, and instrumentation and software design. The workshop also runs a number of Linux servers that host molecular modelling (Accelrys, VASP), Computational Fluid Dynamics (Fluent) and Finite Elements (Abaqus) software that are used in Departmental research. The Electronics Workshop advises staff and students on the conceptual design of instrumentation, data acquisition and control systems for test rigs. The workshop also implements and commissions these systems.

The Electronics Workshop also designs, builds and commissions custom electronics and software solutions tailored to the requirements of the various research groups in the Department. LabVIEW, KiCAD, SolidWorks and other CAD packages, as well as software simulation suites and industry-standard software tools are used.

Mechanical Workshop

The Mechanical Workshop is a well-equipped fabrication workshop, with the capacity for prototype development and customised designs in various materials, including stainless steel and Perspex.

Ms Alvira Mentoor, Lab Manager, Experential Learning Facility: Testing fluid friction equipment for 2nd year students' practical.

The Chemical Engineering Experiential Learning Facility

The chemical engineering curriculum at the University of Cape Town has a strong focus on the integration of theory into practice. To meet this purpose of experiential learning, the undergraduate Experiential Learning Facility comprises equipment demonstrating state-of-the-art technology from various research centres and groups in the Department. This facility has the capacity to demonstrate the core learning elements of chemical engineering practice in a directed manner. The strong link between research and training introduces a detailed understanding of current engineering technologies, some of which have not yet been adopted in industry.

In addition to learning the governing physical and chemical principles, the facility also allows students an opportunity to learn other skills pertinent to the functions of a modern engineer in industry. Data captured using data loggers requires competency in computing skills to enable simplified analysis of the results. Students are also exposed to statistical methods of designing experiments and consequently using these methods to analyse the results. The performance of experiments in teams allows collegial learning, not only deepening understanding of engineering concepts, but developing the life skill of teamwork.

Training in matters related to safety, health and the environment is a key feature of the training conducted in the experiential laboratory, which functions as a low risk entry point for students to become acquainted with complex instrumentation and control protocols on process rigs. This is a skill that they will later use extensively when dealing with larger scale units within the Department and industry.

In summary, the Experiential Learning Facility plays a crucial role in providing knowledge for various engineering concepts and also in building awareness of the role of engineers in technology development and testing.

Undergraduate programme

In the ECSA accredited undergraduate programme, students are equipped for careers both in the process industries and as researchers (though many also take up positions in related/other sectors). This is achieved through an underpinning of mathematics, basic science and engineering science fundamentals; the application of engineering practice related knowledge, tools and skills to solve complex problems; and an exposure to complementary studies in the Faculty of Humanities.

Starting in 2014, a new curriculum has been implemented, with the key drivers being to improve the quality of student learning in the programme, and to increase the contemporary relevance of the offering. 2015 saw the successful launch of a new second year course with tightly integrated theory, tool, project and practical work. For more information, see http://www.chemeng.uct.ac.za/chemeng/new%20curriculum.

Approximately 125 students (from a diverse range of backgrounds) enter the programme each year. The students are supported through a variety of measures, including: a first year mentorship scheme and team-building camp; dedicated year advisers; a well developed tutor system; a one week industrial field trip in second year; and intensive winter and summer boot camps for students experiencing difficulties during the normal semester.

These initiatives have enabled the Department to produce an average of 102 graduates per year in 2012 to 2015 (up from 68 per year in 2007 to 2011), with a record of 114 in 2014. Correspondingly, the minimum-time graduation (i.e. percentage of students completing in four years) for the 2009 to 2012 intake has risen to 50% (from 39% for the 2003 to 2008 intake).

Industrial partners provide many vital inputs to the programme: bursaries for students; placements for student field trips and work experience (which all students must complete to be awarded the degree); service on the Advisory Board and Local Industry Forum; financial support from the Minerals Education Trust Fund; and significant contributions to new and improved equipment and infrastructure.

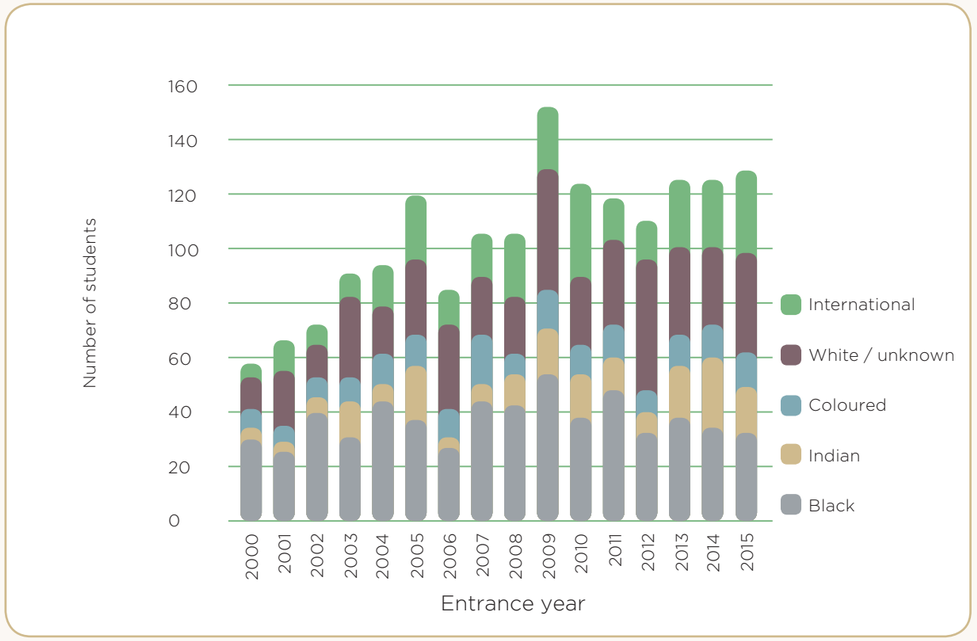


Figure 1: Overall intake between 2000 and 2015 by population group

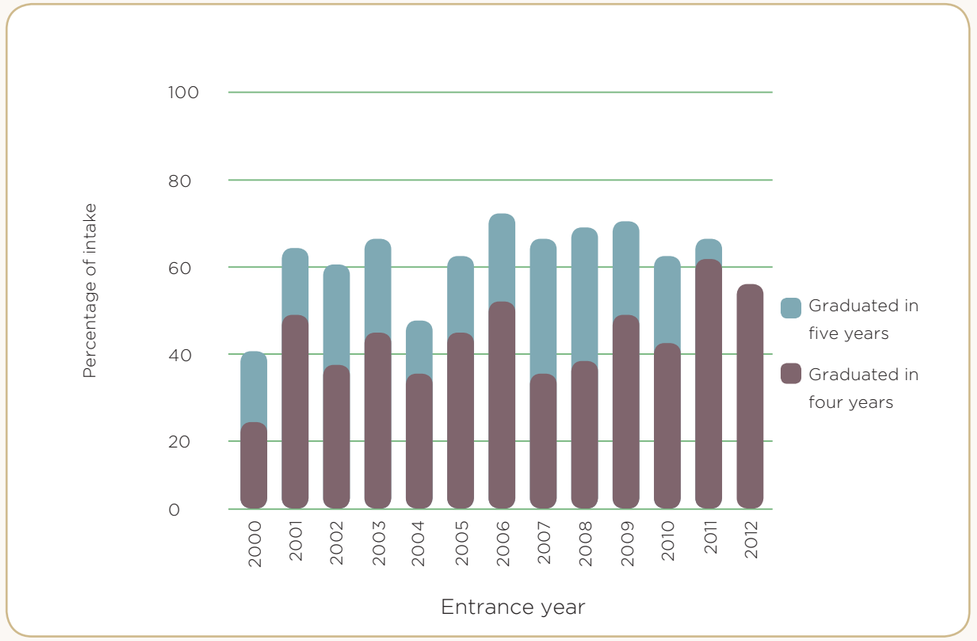


Figure 2: Graduation in minimum time and minimum time +1 between 2000 and 2012

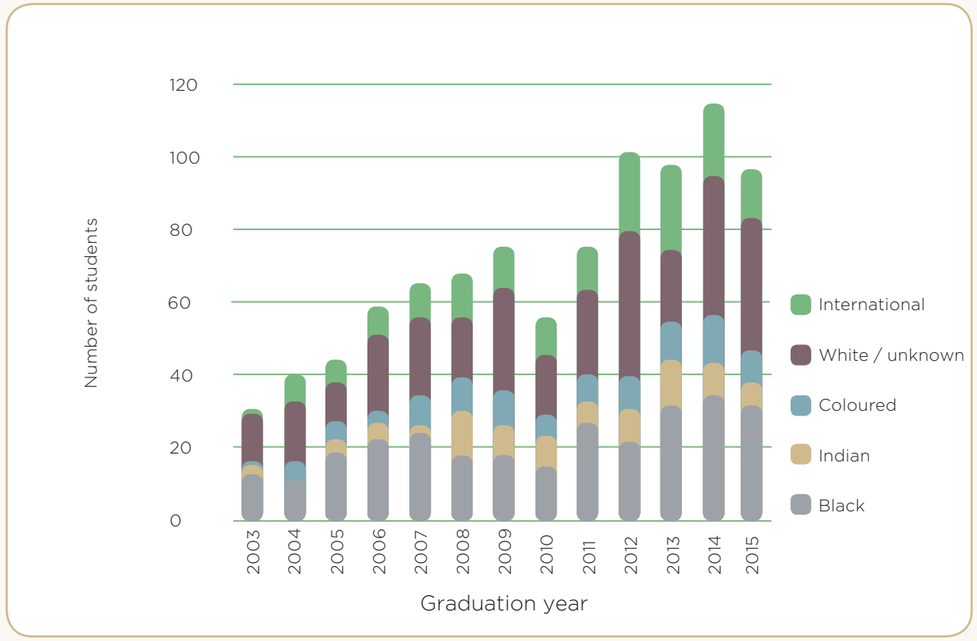


Figure 3: Number of graduates from the programme between 2003 and 2015 by population group

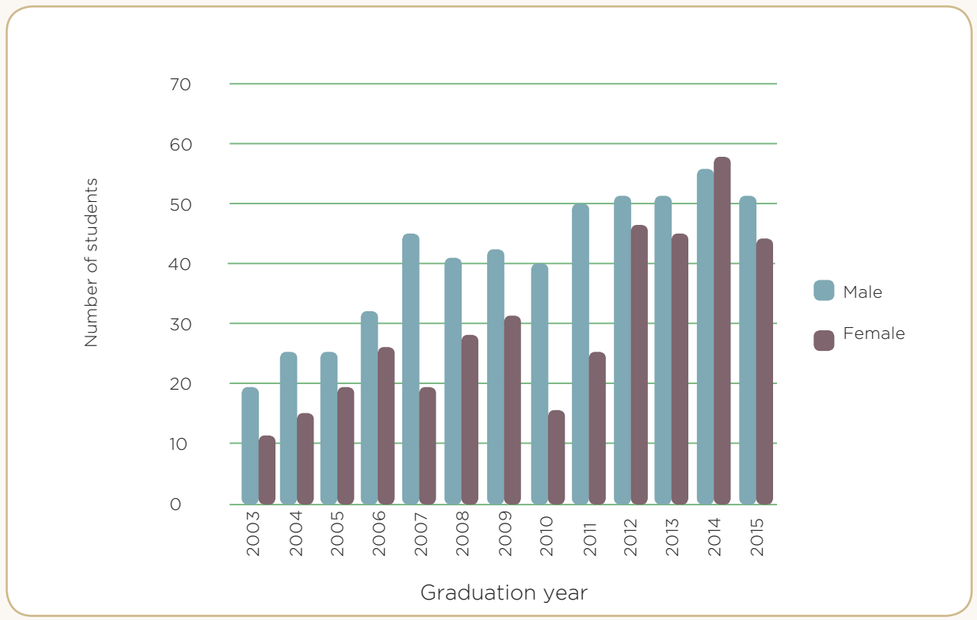


Figure 4: Number of graduates from the programme between 2003 and 2015 by gender

Table 1: BSc Chemical Engineering graduates (114) in 2015

Name	Achievement
Abdullah, Ilyaas	
Adam, Sarah Lynn	First class honours
Amirudin, Muhammad Nurkhairy	
Beare, Peter Aaron	First class honours
Beavon, Corey Gregg	Honours
Beseti, Lelethu	
Bresgi, Daniel Jack	First class honours
Brown, Darryl Edward	First class honours
Burcher-Jones, Cody Owen	Honours
Cahill, William Hugh Alexander	First class honours
Cilliers, Pierre Louis	First class honours
Collins, Ramsay Edward	First class honours
Courtney, Caitlin Emily	First class honours
Dalton, Rowan Michael	First class honours
De Oliveira, Dominic Kyle	First class honours
De Sousa, Claudia Daniella	Honours
De Villiers, Didier Jean	First class honours
Desai, Amisha	Honours
Embling, Nicola Cassandra	Honours
Foulkes, Shaun Michael	Honours
Gogela, Usisipho Thabang	
Govender, Desania Raquel	Honours
Govender, Veleshia	
Harding, Genevieve Elizabeth	First class honours
Heyns, Dale Ashley	Honours
Ho, Darren Sean	First class honours
Hodgson, Tanya	First class honours
Hoey, Cameron George	Honours
Hohana, Zolisa Chuma	
Holt, Jade Cindy	
Jogiat, Mohamed Dawood	First Class Honours
Ju, Wanjiadai	Honours
Kaongwa, Chabala	Honours
Khunoana, Hilda	Honours
Kujoana, Lenned Nkwana	Honours
Lodewyk, Shalisa	Honours
Luna, Luvo	
Mabuka, Thabo	
Machethe, Lebogang Lucia	
Maharaj, Chiara Ms	
Maila, Tshegofatso Florah	
Makhema, Kelebogile Joyce	
Marder, Devin Courtney	
Matsepe, Nkhulang Tebogo	
Matumane, Lineo	
Mayengo, Brian	Honours
Mbombo, Mveleli	
Mc George, Lauren Kim	First class honours
Mc Gregor, Julia Lousie Amelung	First class honours
Mgabhi, Senzo Mntukhona	
Mgqamqo, Saphokazi	
Mgwebi, Yamkela	
Mhlongo, Nompumelelo Precious	Honours
Modukanele, Kagiso Gladwell	
Mokgosi, Mosetsanagape	
Mokhithi, Mashudu	
Molepo, Maisha Tumelo	Honours
Molteno, Christopher Daniel	First class honours
Momoti, Songo	
Moyo, Nontobeko Immaculate	
Mpofu, Nobuhle	
Mung'Asia, Azegele Rony	Honours
Mutambirwa, Keith	
Mutsekwa, Rutendo	Honours
Naidoo, Kyle Camden	Honours
Naidu, Jaishal Dayanandah	
Ncube, Gilbert Winner	
Nel, Dayle	Honours
Ngcobo, Smanga Prince	

Name	Achievement
Ngculu, Zinwe Zika Mdali	
Ngema, Sphamandla	
Ntoane, Rorisang	
Ntozakhe, Vukile Ndumiso Mr	
Pieters, Brandon	Honours
Platts, Alexander Nicholas	First class honours
Ramonnye, Karabo Motsile	
Robertson, Jenny Louise	First class honours
Rodseth, Clare Josephine	First class honours
Rugaimukamu, Queen Christina	Honours
Sadan, Zaynab	Honours
Sewnarain, Prelisha	
Shaw, Murray Leslie	
Simenda, Likoze	Honours
Sojola, Yandisa	Honours
Stegmann, Rosalind Melissa	Honours
Still, Caroline Alexandra	First class honours
Trenor, Erin	First class honours
Tucker, Chelsea Lyn	Honours
Voyi, Onawanda	
Wilson, Sigourney Sigi	
Wu, I-Chen	First class honours
Wu, Yuan-Shiun	Honours
Xie, Wen Tian Helen	Honours
Zaayman, Christopher Hein	Honours
Zimmermann, Felix Rudolf	Honours
Zireva, Rumbidzai Damita	Honours

Professional accreditation

The Department's undergraduate programme is accredited by ECSA, the Engineering Council of South Africa. ECSA accreditation means that the BSc (Chem Eng) graduates meet the requirements to register as candidate engineers for PrEng registration. Although the degree is globally accepted, ECSA accreditation means that the BSc (Chem Eng) qualification is formally recognised by the Washington Accord. This formal recognition thus applies to Australia, Canada, Chinese Taipei, Hong Kong, Ireland, Japan, Korea, New Zealand, Malaysia, Singapore, the United Kingdom and the USA.

The Department was assessed in 2015 and the accreditation was renewed for another five years. The next ECSA visit will take place in 2020. The general observations were that the accreditation team was impressed with the documentation presented to them. Further, the team commended the Department on the structures put in place for student and staff transformation. The team also viewed the taught component around Health and Safety in the curriculum as very favourable.

On the issue of Quality of Teaching and Learning, the comment was:

The team found a generally high level of morale amongst academic staff. Students commented on, but accepted the high workload imposed by the programme requirements. There is general agreement by staff and students that the programme is of a high standard and the team concurs.

The following academic staff members are registered as Professional Engineers (PrEng) with ECSA:

- Prof Cyril O'Connor
- Prof Alison Lewis
- Prof Harro von Blottnitz

NRF rating

The NRF rating system is a key driver in the NRF's aim to build a globally competitive science system in South Africa. It is a valuable tool for benchmarking the quality of UCT's researchers against the best in the world. NRF ratings are allocated based on a researcher's recent research outputs and impact as perceived by international peer reviewers. The rating system encourages researchers to publish high quality outputs in high impact journals. Rated researchers as supervisors will impart cutting-edge skills to the next generation of researchers.

NRF Rated staff members			
Dr	M	Becker	Promising young researchers
Prof	J	Case	Established researchers
Prof	M	Claeys	Established researchers
Dr	K	Corin	Promising young researchers
Prof	D	Deglon	Internationally acclaimed researchers
Prof	S	Harrison	Internationally acclaimed researchers
Dr	A	Isafiade	Promising young researchers
Dr	P	Levecque	Promising young researchers
Prof	A	Lewis	Internationally acclaimed researchers
A/Prof	A	Mainza	Established researchers
Prof	K	Möller	Established researchers
A/Prof	J	Petersen	Internationally acclaimed researchers
Prof	E	van Steen	Internationally acclaimed researchers
Prof	H	von Blottnitz	Established researchers

The ratings that are awarded are as follows:	
A	Researchers who are unequivocally recognised by their peers as **leading international scholars** in their field for the high quality and impact of their recent research outputs.
B	Researchers who enjoy **considerable international recognition** by their peers for the high quality and impact of their recent research outputs.
C	**Established researchers** with a sustained recent record of productivity in the field who are recognised by their peers as having: • produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field; • demonstrated the ability to conceptualise problems and apply research methods to investigating them.
P	Young researchers (normally younger than 35 years of age), who have held the doctorate or equivalent qualification for less than five years at the time of application and who, on the basis of **exceptional potential** demonstrated in their published doctoral work and/or their research outputs in their early post-doctoral careers are considered likely to become future leaders in their field. Also known as the NRF President's Award.
Y	Young researchers (40 years or younger), who have held the doctorate or equivalent qualification for less than five years at the time of application, and who are recognised as having the **potential to establish themselves** as researchers within a five-year period after evaluation, based on their performance and productivity as researchers during their doctoral studies and/or early post-doctoral careers.

Admission requirements

OFFER LEVELS FOR AN ACADEMIC PLACE - 2016 and 2017			
	BAND A Admission guaranteed All applicants	BAND B Admission likely All applicants	BAND C Admission possible Targeted redress race groups 1 and 2 only
Chemical Engineering	85 FPS Mathematics ≥ 80% Physical Sciences ≥ 70% NBT scores of Proficient for AL, QL and Maths	80 WPS Mathematics ≥ 80% Physical Sciences ≥ 70% NBT scores of Intermediate or Proficient for AL, QL and Maths	70 FPS Mathematics ≥ 80% Physical Sciences ≥ 70% NBT scores of Intermediate or Proficient for AL, QL and Maths

Ms Tokoloho Rampai and CHE2005W tutor, Mr Kudzai Chiodza

Postgraduate programme

The postgraduate programme is a core component of the offerings of the Department. The postgraduate students play a crucial role as tutors in the undergraduate courses, and thus the postgraduate programme, and the participation of excellent postgraduate students is essential to the functioning of the Department as a whole.

The Department offers the PhD (by dissertation), the research only MSc (by dissertation), the taught MSc (by coursework and dissertation) and the taught MPhil (by coursework and dissertation). These degrees may be carried out in any of the following research areas: bioprocess engineering, catalytic process engineering, crystallization and precipitation, engineering education, environment and process systems and mineral processing.

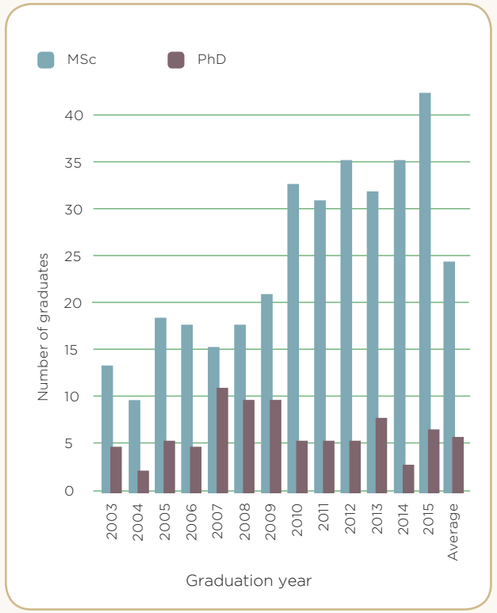


Figure 5: Number of Msc and PhD graduates between 2003 and 2015

The MSc by combination of coursework and research is offered in the areas of bioprocess engineering, catalytic process engineering and hydrometallurgical engineering.

All postgraduate studies based in the Department of Chemical Engineering involve a substantial research project. All on-site students entering for a postgraduate degree in the Department of Chemical Engineering are required to undertake the course on Research Methodology and Communication (CHE5055Z). The research questions to be investigated for their thesis are formulated and defined as a part of this course.

Students may enrol for PhD study after completion of their MSc study or via an upgrade of their MSc to a PhD study. Prospective PhD students are required to submit a written research proposal and to present their proposal in a seminar to the Department. The proposal is reviewed by a panel comprising three academics who advise the Head of Department whether the provisional registration should be upgraded to a PhD registration. The registration of the student as a PhD student must subsequently be sanctioned by the Doctoral Degrees Board.

The figure shows the number of MSc (including MPhil) and PhD graduations from the postgraduate programme as a whole over the last 12 years. The table lists postgraduate students who graduated during 2015, and gives an indication of the scope of research projects conducted in the Department of Chemical Engineering.

Table 2: Postgraduate students who graduated during 2015

Name	Degree	Supervisor	Title
Zaheera Ahmed	MSc	Prof J Fletcher	The use of ruthenium Y zeolite catalysts for the selective methanation of carbon monoxide
Takunda Chitaka	MPhil	Prof H von Blottnitz	Sustainability performance analysis and decision-making for minerals beneficiation
Tapiwa Chivenga	MSc	Dr O Conrad	Microchannel flow fields for polymer electrolyte fuel cells
Joanne Crimes	MSc	Dr AJ Isafiade	Assessment of pre-treatment technologies for bio-ethanol production using multi-objective optimisation
Simone Daniels	MSc	Mr N Hussain	Water management strategies for polymer electrolyte fuel cells (PEFCs) employing microchannel flow fields
Darin Dickson	MSc	Prof S Harrison	Development of an eicosapentaenoic acid production bioprocess using an indigenous micralgal isolate
Zethu Dlamini	MSc	A/Prof J Petersen	A techno-economic comparison of three process routes for the treatment of Gamsberg zino ore
Vuyiswa Dube	MSc	Prof A Lewis	Study of selective removal of CoS and NiS during purification of manganese (II) sulphate electrolyte
Malikaah Galant	MSc	Prof C O'Connor	The characterisation of the lead flotation circuit at Black Mountain Mining using the floatability component model approach
Sibonginseni Gqebe	MSc	Prof A Lewis	Improving the settle ability of a metal sulphide suspension by the application of a magnetic field
Elaine Govender	PhD	Prof S Harrison Dr CG Bryan (Exeter)	Investigating the growth kinetics and colonisation of *Acidithiobacillus ferroxidans* on whole low-grade chalcopyrite ore at various physico-chemical conditions at the agglomerate-scale

Name	Degree	Supervisor	Title
Dirren Govender	MSc	Prof K Möller	A computational study on methane/n-heptane/air spherically propagating laminar flame speeds within a constant volume combustion bomb
Ntandoyenkosi Hlabangana	MSc	Dr P Levecque	Influence of particle size and morphology of Pt_3Co/C on oxygen reduction reaction
Precious Hlongwane	MSc	Prof S Harrison	The influence of solid loading and particle size on the characterisation of sulphide containing ores using the biokinetic test for AMD
Judith Iroala	MSc	Prof J-P Franzidis Prof S Harrison	Comparison of froth flotation and gravity separation of the Waterberg and Witbank coal ultra-fines in terms of mitigation of ARD
Sarah Jones	PhD	Prof S Harrison	Mixing, mass transfer and energy analysis across bioreactor types in microalgal cultivation and lipid production
Fadzai Kadzinga	MSc	Prof S Harrison	Venturi aeration of bioreactors
Monica Kalichini	MSc	Dr K Corin	A study of flotation characteristics of a complex copper ore
Makhosazane Kunene	MSc	Dr J Broadhurst	Life cycle assessment of the production of Xanthate salts and of their application of ARD mitigation
Cong Liu	MSc	Prof J-P Franzidis	New techniques for radiolabelling tracers with Cu for positron emission particle tracking (PEPT) experiments
Timothy Magezi Ndamira	MSc	Prof H von Blottnitz	An investigation of the imbalance of a fast-growing consumer culture and insufficient waste management Infrastructure across a number of sub-Saharan Africa cities
Tafadzwa Marozva	MSc	Dr B McFadzean	Investigating the effect of frother type on froth structure, froth recovery and entrainment
Tiisetso Moimane	MSc	Dr K Corin	Investigation of the effect of the reagent suite in froth flotation of a Merensky ore
Latifa Mrisho	MSc	Prof S Harrison Dr C Fenner	Production and characterization of alkaliphilic amylases from *Bacillus halodurans* Alk36

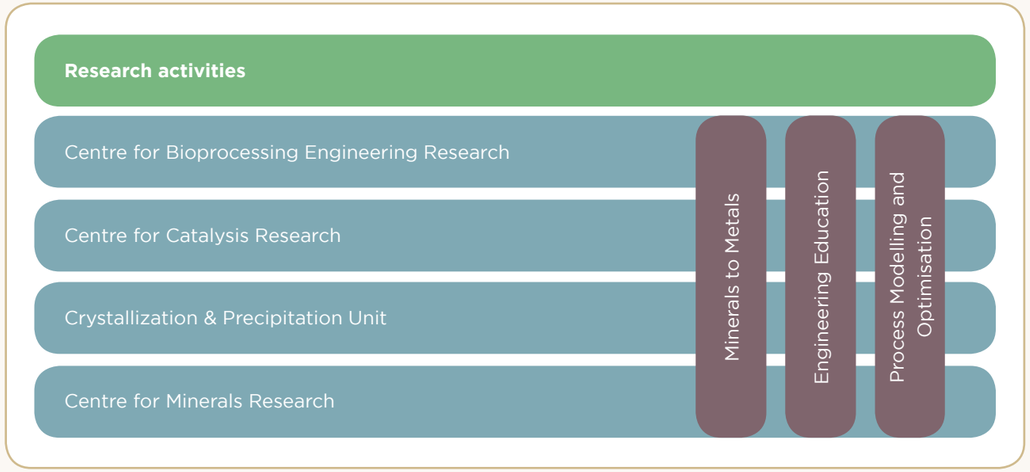
Name	Degree	Supervisor	Title
Kabwe Musonda	MSc	A/Prof A Mainza	Ammonia leaching as a pre-treatment for the processing of oxidised PGM
Adolf Mwale	MSc	A/Prof A Mainza	A mathematical model for predicting classification performance in wet fine screens
Doreen Naboho	PhD	Prof E van Steen	Hydrogen spill over in the Fischer-Tropsch synthesis – the roles of platinum and gold as promoters of cobalt-based catalysts
Faustine Ngoroma	MSc	Prof J-P Franzidis	Investigation of the effect of different frother blends on the flotation of selected PGM bearing ores
Lefa Nkadimeng	MSc	Prof S Harrison	Maximising energy recovery from the brewery wastewater treatment system: A case study evaluating the anaerobic digestion wastewater treatment plant at SAB's Newlands Brewery
Wadzanai Nyabeze	MSc	Dr B McFadzean	The effect of copper sulphate on froth stability
Edward Peters	MSc	Dr M Rodriguez	Effect of antiscalantz on eutectic freeze crystallization of a reverse osmosis retentate
Keshree Pillay	MSc	Dr M Becker	Mineralogical effects on the dense medium separation of low grade nickel sulphide ore
Shilpa Rumjeet	MSc	Prof S Harrison	Systematic investigation of potential factors that affect the production costs of the bio-based and bio-degradable plastic polyhydroxyalkanoates (PHAs) by a costing analysis based on early process simulation
Mamohlomi Senoko	MSc	A/Prof J Petersen	Osmium tetroxide behaviour in acidic ruthenium scrub liquors
Caelin September	MSc	Dr P Leveque	Preparation and characterisation of inorganic nanostructured support materials for polymer electrolyte fuel cells
Melissa Sikosana	MSc	Prof H von Blottnitz	A technological, economics and social exploration of phosphate recovery from centralised sewage treatment in a transitioning economy context

Name	Degree	Supervisor	Title
Evan Smuts	PhD	Prof D Deglon	A methodology for coupled CFD-DEM modelling of particulate suspension rheology
Margreth Tadie	PhD	Dr K Corin	An electrochemical study of platinum group minerals
Jestos Taguta	MSc	Dr B McFadzean	The thermochemical behaviour of thiol collectors and collector mixtures with sulphide minerals
Franschua Van der Walt	MSc	Prof J Fletcher	Factors influencing the catalytic activity of Fe-ZSM-5 during the catalytic conversion of N^20
Michael Van Heerden	MSc	Prof J-P Franzidis	Improving the selectivity of the radio-labelling of ion exchange resin tracers for positron emission particle tracking
Charl Van Schalkwyk	MSc	Dr S Blair	The development and scale-up of enhanced oxygen reduction reaction (ORR) catalysts for hydrogen fuelled low temperature PEMFCs
Hundzukani Vukeya	MSc	Dr C Woolard	The use of model compounds to investigate the influence of fuel composition on the thermal oxidative stability of fame/diesel blends
Philasande Xalabile	MSc	Prof J Fletcher	Development of bimetallic Pd-Zn catalysts for methanol steam reforming: Hydrogen production for fuel cells

Research in Chemical Engineering

Research in the Department of Chemical Engineering has grown significantly over the last 10 years, with postgraduate numbers increasing from 92 in 2002 to 186 in 2015.

The Department hosts three university accredited research groupings: the Centres for Bioprocess Engineering Research, Catalysis Research and Minerals Processing Research and the Crystallization and Precipitation Research Unit. We also host two SARChI Chairs (Bioprocess Engineering and Minerals Beneficiation), the DST - NRF Centre of Excellence in Catalysis, the DST Competence Centre in Hydrogen and Fuel Cells as well as one of the university's Signature Research Themes in Minerals to Metals.



Noteworthy research related achievements in 2015

Michael Claeys and Eric van Steen, Centre for Catalysis Research, most prolific publishers in a proceeding for a calendar year based on weighted outputs.

Michael Claeys, Honorary visiting professor – Cardiff University.

Mpendulo Ncongwane, Minerals to Metals MSc student, received the award Winner Outotec prize for the Sustainability in the Minerals Industry.

Bridget Fundikwa, a Minerals to Metals and CeBER MSc student, was awarded the Outotec second prize for the best student paper and poster on "Sustainability in the Minerals Industry" at MinProc 2015.

Thulani Nyathi, Centre for Catalysis Research, recipient of the best oral presentation award at the annual meeting of the Catalysis Society of South Africa (CATSA).

Anna Petersen, Centre for Catalysis Research, recipient of the best poster presentation at the annual meeting of the Catalysis Society of South Africa (CATSA) held at the Arabella Hotel and Spa in Kleinmond on 15 to 18 November 2015.

Shiro Tanaka, Centre for Catalysis, first prize at the AVI awards for his prototype unmanned aerial vehicle. The award was enabled by HySA/Catalysis, in particular, Dr Shiro Tanaka of HySA/Catalysis (UCT), who led the technical effort on the design of the fuel cell stack, and Professor Arnaud Malan and his team from the Department of Mechanical Engineering, who were responsible for the aerodynamic modelling of the UAV.

Tarryn Terry, a CeBER, MSc student, second in the category "Best Student Oral Presentation" at the 29th Congress of the Phycological Society of Southern Africa.

Alex Opitz, a Minerals to Metals and CeBER PhD student, was awarded one of two 2015 Outotec scholarships for his PhD project on The "development of an integrated approach for ARD prediction from waste rock." These scholarships seek to promote sustainable minerals processing in southern Africa and to inspire the abundant young South African talent to innovate in this area.

Lorenz Biegler, The department hosted Lorenz Biegler, Bayer University Professor and Head, Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, USA, from 29 July to 8th August 2015. During this visit, Prof Biegler presented to a broad audience a seminar titled "Multi-scale optimisation for chemical processes", followed by a short course. The visit has also set the scene for student exchange to Carnegie Mellon University and has also become part of NRF and other research grant applications.

Alison Lewis – CPU - WRC Knowledge Tree Award for research excellence in the category of New Products and Services for Economic Development.

Alison Lewis – CPU - Second most cited article in Hydrometallurgy: 2010. A review of metal sulphide precipitation, Hydrometallurgy, 104 (2) 222-234

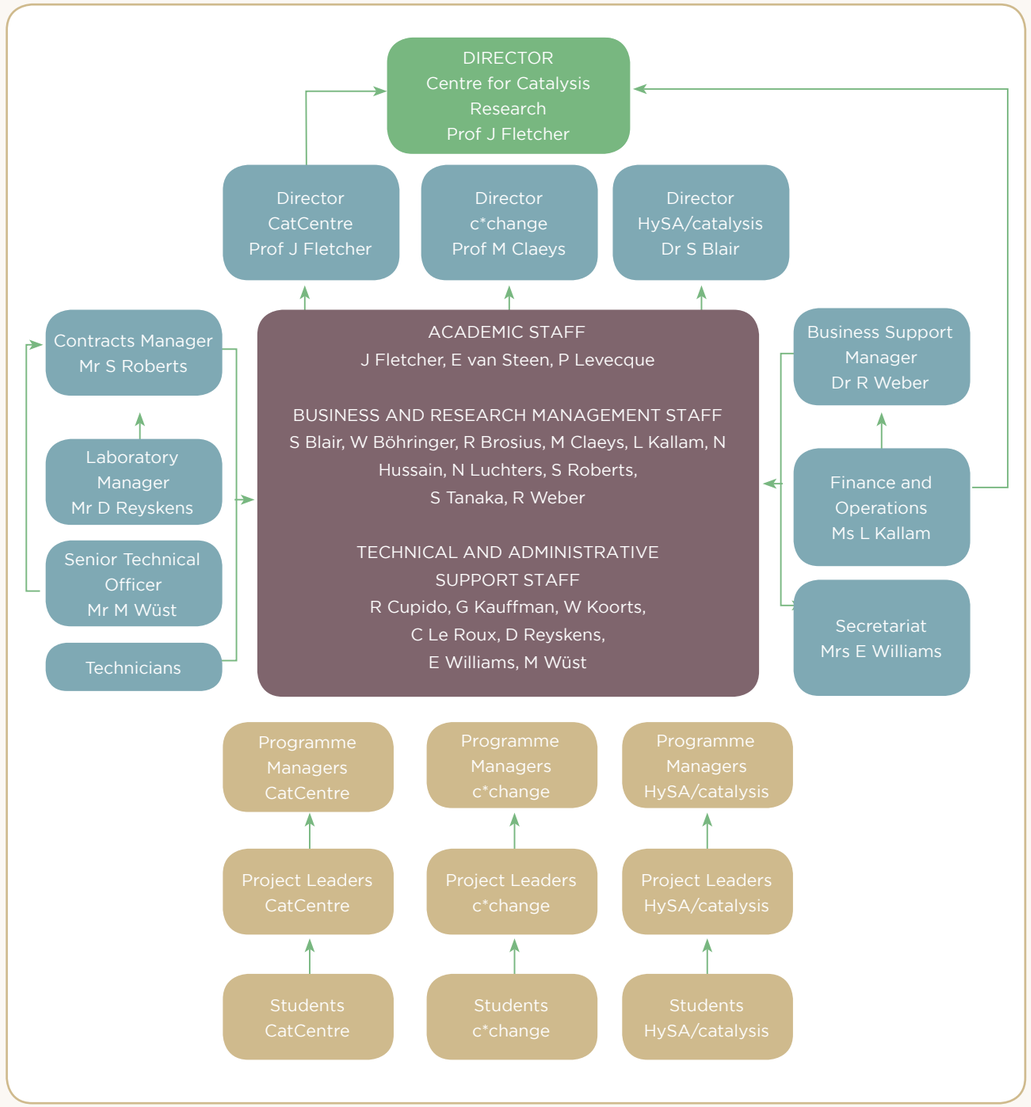
Brewing UCT, sponsored by CeBER, won two top prizes at the annual brewing intervarsity competition in Johannesburg. The wins were for the Best Lager, and overall Best Beer. This was the first time the UCT team managed to pick up the best lager award.

The University of Cape Town won the 8th Annual SAB Intervarsity Beer Brewing Challenge 2015 held at the SAB Cyril Ramaphosa World of Learning in Kyalami, Johannesburg.

Brewing UCT was awarded the Ben Lamaletie IBD Intervarsity Beer Brewing Challenge Trophy, the Castle Lager Best Bru Award and the Carling Black Label Champion Lager Award for their Munich Dunkel lager named 'Don't Dunkel with my Heart'

From left: SAB Trade Brewer Newlands Brewery, Denis da Silva with University of Cape Town team members; Brian Willis; Catherine Edward; Alex Opitz; Bronwyn White and Rob Huddy; and SAB Director Supply Chain and Technical, Stanislav Maar.

Centre for Catalysis Research



Description of activities

Research

Research in catalysis at UCT Chemical Engineering currently consists of three main entities.

Centre for Catalysis Research (CatCentre)

Industrially-oriented catalysis research was initiated within the Department of Chemical Engineering in 1980. Funding comes from a variety of sources including the university, the National Research Foundation (NRF), the DTI Technology and Human Resources for Industry Programme (THRIP), and several industrial sponsors. Industrial contract research from both domestic and international companies contributes substantially to the centre's financial base.

The centre concerns itself with both fundamental and industrial research and development in the general field of heterogeneous catalysis, encompassing all of catalyst synthesis, physico-chemical characterisation, and performance testing for industrially interesting chemical conversions. Although engaged in topics of international interest, the centre has a strong commitment to addressing issues of direct importance to the South African chemical process industry.

The CatCentre scientific programme is made up of three distinct research foci, namely:

1. Fischer-Tropsch synthesis.
2. Hydro processing.
3. PGM catalysis.

DST-NRF Centre of Excellence in Catalysis (c*change)

The DST-NRF Centre of Excellence in Catalysis (c*change), established in 2004, focusses on the field of catalysis and catalytic processing, and is to be seen as a large, yet focused virtual research programme of a national scope and significance, with multi-disciplinary participants from 10 higher education institutions, comprising some 16 research groupings from fields in heterogeneous, homogeneous, and bio-catalysis and disciplines ranging from chemistry, engineering, and microbiology.

The objectives of the Centres of Excellence Programme are, *inter alia*, to promote knowledge and human capital development in areas of strategic importance to South Africa, to promote collaborative and inter-disciplinary research, to integrate smaller and related research areas into one programme, and to strive for the highest standards of quality and international competitiveness by exploiting the competitive advantage vested in outstanding researchers with planned, strategic, long-term research.

The c*change scientific programme is made up of four distinct research programmes:

1. Paraffin Activation (PAR) Programme (UCT, US, UKZN, UFS).
2. RSA Olefins (OLE) Programme (UCT, US, UFS, NWU, UJ).
3. Synthesis Gas (SYN) Programme (UCT, WITS, UWC, UL, UNISA).
4. Small Volume Chemicals (SVC) Programme (UCT, NMMU).

DST Hydrogen Catalysis Competence Centre (HySA/Catalysis)

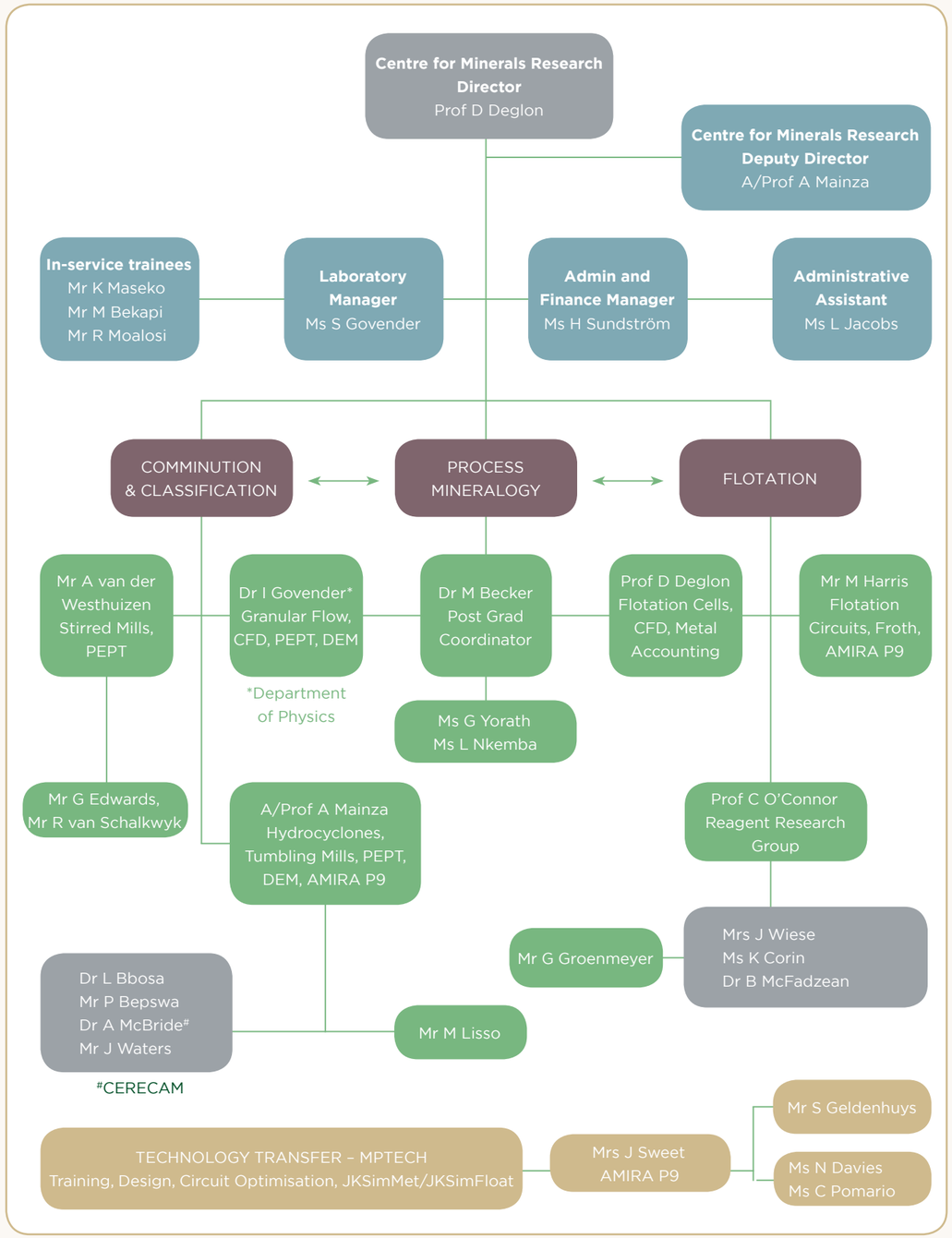
The Centre for Catalysis Research, together with the mineral research council, Mintek, hosts the Department of Science and Technology's (DST) Hydrogen Catalysis Competence Centre. This virtual centre, established in 2007, is one of three competence centres that will develop hydrogen-based technologies as part of the National Flagship Project in Hydrogen and Fuel Cell Technologies. Platinum-group metals are key catalytic materials in hydrogen fuel cells and South Africa has a unique driver in that it possesses 75% of the world's platinum reserves. The strategic goal is for South Africa to supply 25% of the future global fuel-cell market with novel, locally developed and fabricated platinum-group metal catalysts by 2020, thereby diversifying the applications of the nation's platinum group metal resources and promoting socio-economic benefits through value addition to its key natural resources.

The *HySA/Catalysis* scientific programme is made up of three core technology programmes:

1. H_2 MeOH Fuel Cells (Mintek).
2. H_2 Reformate PEM Devices (UCT).
3. Fuel Processor (UCT, UKZN).

In addition to scientific development, *HySA/Catalysis* is responsible for the *HySA* Key Programme in Portable Power Systems.

Centre for Minerals Research



Description of activities

The Centre for Minerals Research is a multi-disciplinary, interDepartmental research centre based in the Department of Chemical Engineering, in close collaboration with groups in the Department of Physics and Mechanical Engineering and the Centre for Research into Computational and Applied Mechanics. The centre originated as a research group in 1980 and became formally recognised as a research unit in the 1990s.

In 2006, the unit was accredited by the university as a research centre. The main focus of research is on the processes of froth flotation, comminution and classification, arguably the most important unit operations in mineral beneficiation. In excess of 2 000 million tons of more than 100 different mineral species are recovered annually through the process of flotation, in most cases preceded by comminution and classification. Inefficiencies in these processes translate into both an enormous loss of revenue and an unnecessary waste of the world's valuable and steadily declining mineral reserves. The primary objectives of the centre are to investigate flotation, comminution and classification at both an industrial (applied) research level and at a laboratory (fundamental) research level, so as to develop a sound understanding of these processes, thereby enhancing our ability to develop predictive models for describing the performance of industrial units and circuits.

In addition, the centre places a high priority on the provision of high level human resources to the South African mining and minerals processing industry through rigorous postgraduate research training. The centre enjoys extensive support from statutory funding agencies as well as a wide spectrum of leading mining and mineral processing companies both locally and globally. The centre also enjoys close collaboration with other research groups at universities and research organisations both nationally and internationally.

Centre for Minerals Research (research themes)

Research in the centre is broadly 'themed' into comminution and classification, flotation, process mineralogy and technology transfer. Process mineralogy is an inter-disciplinary research area that plays an important role in the integration between comminution, classification and flotation. A technology transfer group, MPTech, plays a central role in ensuring that research outcomes are implemented. Research is conducted at both an industrial (applied) level and at a laboratory (fundamental) level. Much of the research is focused on developing predictive models for describing the performance of industrial units and circuits.

Comminution and classification research

- Comminution Circuit Modelling (Group Leader: Aubrey Mainza);
- Computational Modelling (Group Leaders: Aubrey Mainza and Indresan Govender); and
- Positron Emission Particle Tracking (Group Leaders: Aubrey Mainza and Indresan Govender).

Flotation Research

- Flotation Chemistry (Group Leader: Cyril O'Connor)
  1. Reagent Research Group.
  2. Flotation Chemistry Group.
- Flotation Cells (Group Leader: Dave Deglon)
  1. Flotation Cell Modelling.
  2. Computational Fluid Dynamics.
- Flotation Circuit Modelling (Group Leader: Martin Harris)
- AMIRA P9 Project (Group Leader: Martin Harris).

Process Mineralogy Research

- Process Mineralogy (Group Leader: Megan Becker).
  1. Process Mineralogy Research.
  2. QEMSCAN.

Technology Transfer

- MPTech (Group Leader: Jenni Sweet).
  1. Technology Transfer, Training, Design Reviews, Circuit Optimisation.
  2. Anglo Platinum Graduate Development Programme.

Centre for Bioprocess Engineering Research (CeBER)

CeBER Director
Prof Sue Harrison

Academic
Assoc Prof Jochen Petersen
Dr Siew Tai
Dr Marijke Fagan-Endres

Administration and Finance Manager
Ms Sue Jobson

Personal Assistant
Ms Sandra Christian

Laboratory Manager
Mr Tich Samkange

Research Officers
Dr Caryn Fenner
Dr Madelyn Johnstone-Robertson
Dr Rob Huddy

Administration Assistant
Ms Candice Mazzolini

Administration Assistant
Ms Lesley Mostert

Laboratory Manager
Mr IE Ngoma
Fe & S

Postdoctoral Researchers
Dr Juarez Amaral Filho
Dr Palesa Diale
Dr Thanos Kotsiopoulos
Dr Tobi Louw
Dr Rob Pott
Dr Mariette Smart

PhD students
Alex Opitz, Alexey Cherkaev, Bernelle Verster, Brian Willis, Cindy-Jade Jenner (Africa), Didi Makaula, Durgaprasad Madras Rajaraman Iyer, Dylan Stevens, Edith Mshoperi, Elaine Govender, Fadzai Kadzinga, Gavin Jones, Helene-Marie Stander, James Mwase, Liabo Motleleng, Mahdi Ghadiri, Marc Brighton, Naadia van der Bergh, Nosaibeh Nosrati Ghods, Qubekani Ngulube, Rajesh Sharma, Sarah Jones, Shanna Swart, Thandazile Moyo, Wynand van Zyl

Technical assistants
Ms Sharon Rademeyer

Research Associates
Dr Chris Bryan
Dr Clive Garcin
Dr Melinda Griffiths
Dr Rob van Hille

Interns
Ms Linda Hanise
Ms Jessica Hitchcock
Mr Tolbert Goleka

MSc students
Bridget Fundikwa, Bronwyn White, Buhle Manana, Caryn Hobbs, Catherine Edward, Darin Dickson, Francois de Flamngh, Gordon Dodge, Hedda Inderthal, Jennifer Couperthwaite, Jian June, Jonathan Dean, Kabwe Musonda, Kathija Shaik, Kemi Jegede, Latifa Mrisho, Lefa Nkadimeng, Mark Gituma, Mark Kerr, Matthew Burke, Matthew Myers, Michael Odidi, Michael Shaw, Motlalekgomo Mogale, Muven Naidoo, Natasha Davids, Nathan Simunika, Precious Hlongwane, Rory Ravells, Rory Stott, Sabastian Naiker, Shilpa Rumjeet, Tarisayi Matongo, Tarryn Terry, Tayana Raper, Tynan Marais, Winful Msipa, Zethu Dlamini

UCT's research in bioprocess engineering originates in the late 1960s. The research grouping was formalised as an accredited unit in 2001 and upgraded to the Centre for Bioprocess Engineering Research (CeBER) in 2008. In 2014, the centre underwent an external review process through the University Research Committee, which commended the progress, particularly its inter-disciplinary strengths in bioprocess engineering, since its inception and affirmed the accreditation as a centre.

CeBER's vision is to be an inter-disciplinary research enterprise, developing the nation's bioprocess engineers, providing new insights into bioprocesses and bioproducts, and becoming a global leader in selected research niches. The mandate is to educate students in bioprocess engineering and biotechnology principles and practice, and to engage in inter-disciplinary research programmes that provide fundamental knowledge and develop technologies to benefit the bioprocess and biotechnology sectors. CeBER is recognised for its strong inter-disciplinary focus, integrating biological understanding and process engineering systems. Particular strengths are in bioreactor design, integrated and sustainable bioprocesses, microbial ecology and associated dynamics, solid-liquid-gas contacting, mass transfer and fluid flow. Areas of application include mineral bioleaching, value from waste, considering solid waste, wastewater and mine water, algal biotechnology, alkane biotechnology, commodity products and vaccines. CeBER addresses trans-disciplinary areas through the analysis of the social, environmental and economic impact of its research.

Research focal areas and projects

Algal biotechnology

Microalgae have great potential as a biomass and bioproduct production system, owing to their broad product spectrum, photosynthetic metabolism and ability to use CO_2 as their carbon feedstock. CeBER focuses on integrated algal processes for the production of pigments, including carotenoids, nutraceuticals, lipids and energy products in both ponds and closed photo bioreactors. In addition, the role of algae in CO_2 uptake and the potential of algae to bio-concentrate metals from wastewaters is under consideration as are low energy bioreactors. Through the biorefinery concept, inventory analysis, and life cycle assessment (LCA), key contributions required for feasible algal processes may be identified. Design of efficient low energy reactor systems is a key focus.

Selected projects: optimising productivity of biomass, lipid and other products; sustainable algal biorefineries; optimising light provision through reactor design; energy-efficient mass transfer; PEPT tomography of fluid flow in photo bioreactors; spirulina technology development; and pigment production.

Biotechnology towards chemicals, food and health products

Research in fine chemicals and commodity bioproducts is through a combination of process kinetics, metabolic modelling, product optimisation, induction and process sustainability. Commodity bioproducts, such as biofuels platform chemicals and polymers are produced, from renewable resources. Bioconversion of linear alkanes yields value-added products such as alcohols and carboxylic acids, balancing enzyme conversion and cofactor regeneration. Recombinant microbial systems are used to maximise productivity of affordable, modern nutraceuticals and natural pigments. Cell culture biopharmaceuticals, for plant cells and algal cells, as well as novel approaches for genetic modification of the algal system are under development.

Selected projects: biofunctionalisation of alkanes; influence enzyme location on

optimising of production; biopolymers from waste resources; biohydrogen production; novel antibiotics from South African actinomycetes; microbial pigments; value addition to sugar based products; determining bioactivity using microcalorimetry and other approaches for process monitoring. Energy-efficient gas-liquid mass transfer.

Mineral bioprocessing

In mineral bioleaching, microbial biocatalysts ensure provision of leach agents for solubilisation of metals from minerals, providing an alternative for recovery of metals such as copper, zinc or gold from low-grade ores or niche concentrates. Research focuses on the sub-processes within heap bioleaching, chiefly microbial ecology structure-function relationships, microbial colonisation and attachment, whole ore growth studies, heap hydrology, solution flow and contacting with the mineral phase. The same understanding is used to minimise ARD. Intensification of tank bioleaching and microbial ecology in these systems is studied. Valorisation of secondary resources, including mine waste and urban waste forms a key component of our circular economy approach.

Selected projects: dynamics of micro-environments within heap bioleach processes; visualisation of leaching-related sub-processes at the agglomerate scale; solid-liquid contacting and solution flow, microbial speciation in the BIOX™ process; intensification of tank leaching; closing the water balance in bioleaching circuits; characterising mineral leaching from large particles; oxidative stress and its role in mineral bioleaching; and approaches to and benefits of minimising the formation of ARD. Value recovery from mine waste. Value recovery from electronic waste.

Hydrometallurgy

The broader suite of hydrometallurgical processes connected with bioleaching processes are also studied. This involves chemical leaching in cyanide and chloride media, fundamental kinetic studies, gas-liquid mass transfer and diffusion phenomena, solution purification through SX and IX, and treatment of effluent streams. Research includes the mechanistic modelling of transport-reaction phenomena in leaching processes, especially in the context of heap (bio) leaching.

Selected projects: cyanide leaching of crushed and run-of-mine PGM ores; integrated leaching of base metal sulphides and PGMs in ammonia and thiocyanate systems, electrochemical studies of mineral leaching; and hydrometallurgical process analysis.

Water and the environment

Water scarcity is a key driver in South Africa. Our research focuses on water treatment for the delivery of compliant , 'fit for purpose' and, where required, portable water from 'people' and industrial wastewater streams with the simultaneous recovery of values using a circular economy approach. Acid rock drainage prevention is considered through enhanced management of waste materials (see mineral bioprocessing). A key component of this is the development and refinement of the tools used for characterisation and prediction of ARD generation. ARD remediation using integrated biological technologies is studied with particular emphasis on recovery of elemental sulphur. Remediation of process and domestic wastewaters is also under investigation with associated value generation. Focus is on integrated systems, microbial ecology and the potential for value recovery, largely through exploring the concept of a waste (water) bio-refinery. CeBER has expertise in sustainability and life cycle analyses, and emerging technologies for renewable energy and greenhouse gas emission reductions. Environmental assessment of bioprocesses considered using tools such as LCA is incorporated throughout our research portfolio.

Selected projects: optimisation of the ASTER™ process for biological removal of thiocyanate and cyanide; enabling quantitative microbial ecology studies of sulphate reducing and sulphide oxidising systems; biological sulphate reduction as a strategy for ARD treatment; ARD preventing Bioremediation of vinesse; anaerobic digestion development of systems for simultaneous production and recovery of valuable products and water purification. Wastewater biorefineries.

Crystallization and Precipitation Unit (CPU)

Industrial crystallization research was initiated in the Department of Chemical Engineering in 2000 and the Crystallization and Precipitation Research Unit was formally accredited by the university in 2006. The unit underwent a formal international review in 2014, during which the unit was congratulated on the focus and research direction, as well as the quality and synergistic nature of the research. The unit was then re-accredited by the University Research Committee for a further five years.

It is interesting that, although crystallization and precipitation are very old industrial processes, with the first applications of industrial crystallization being before 1500 BC (by the Egyptians, who produced alum); and the first applications of precipitation being in the 1860s (the Solvay process for producing sodium bicarbonate) the formal study of crystallization process only began in the early 1800s, and of precipitation in the 1930s. Precipitation, in particular, is not a very well understood process.

Therefore, the main aim of the research unit is to advance existing fundamental knowledge in the fields of crystallization and precipitation, especially related to the South African and international mineral processing and extractive metallurgy industries.

The unit focuses on two main areas:

1. Optimising precipitation in hydrometallurgical processes. The unit's work on palladium precipitation, rhodium precipitation and Mixed Metal Sulphide precipitations are examples of this.
2. Development of innovative technologies for brines and mining wastewater treatment. The Eutectic Freeze Crystallization project is an example of this.

The tools used in the research include modelling and simulation approaches to industrial research, such as the particle rate process approach for modelling of industrial crystallization processes; aqueous chemistry modelling and computational fluid dynamics modelling.

Research in Engineering Education

Prof Jenni Case
Mr Hilton Heydenrych
Ms Carol Carr

It is no surprise that a Department with a deep interest in its undergraduate programme, as well as a thriving research culture, would have spawned a focus on engineering education research aimed at understanding and improving the student experience of learning.

The centre's research over the last two decades in this area has generated important insights in the following key areas:

- Need for a conceptual (deep) approach to learning for success in the programme.
- Impact of an overloaded curriculum on a student's ability to adopt an appropriate approach to learning.
- Need to facilitate broader personal development amongst students and to build peer networks in class.
- Value of using simulation to build understanding of chemical engineering fundamentals.
- Use of technology (including laptops in class) to support active engagement and high-quality project work.
- Limited value of innovation in one course alone and thus the need to build coherence across the curriculum to support high quality learning.

Duncan Fraser was one of the early engineering education researchers at UCT and in retirement he continued to be active. His research focused on improving student learning, in particular through the application of variation theory and through the use of computer simulations. His most recent research work focused on applying complexity theory to the analysis of student success in collaboration with Prof Cedric Linder from Uppsala University in Sweden. At the time of his passing in 2014, Duncan was working towards an approach for characterising student success in the context of curriculum change in chemical engineering at UCT, a project where he was also very actively involved in developing innovative materials for project and practical work. His legacy is still very much with us.

Jenni Case, who joined the Department in the first academic development lecturer (ADL) post in the faculty, was first in the faculty to obtain a PhD in engineering education. Her PhD research studied student learning in a second-year chemical engineering course, focusing on the evolution of appropriate approaches to learning for success in this course. From this point, she has continued with a sustained programme of research into student learning and her work is published across engineering education and higher education literature. Much of this work has had an empirical departure point the experiences of students in the chemical engineering programme at UCT. Her recent work moves into the area of curriculum, in order to better map out the structural and cultural constraints that operate to condition the space for student learning.

ChemEng Boot Camp

Hilton Heydenrych and Masters student Rony Azegele in Chemical Engineering Reading Room

Hilton Heydenrych, a second ADL in the department, focuses part of his scholarly work on engineering education, bringing strength particulary in analysing student throughput data and other quantitative aspects of the work in the group. Together with Jenni he is developing a project around the graduate destinations of UCT chemical engineering graduates.

Duncan Fraser and Jenni Case were both founding members of the Centre for Research in Engineering Education (CREE) in the mid-1990s (with Duncan having been one of the two co-founders of CREE), and each has served an extended term as director of this centre. A key development over this period of establishing engineering education research at UCT has been the support of key academics in EBE to obtain PhDs in engineering education. Jenni Case has supervised or co-supervised many of the PhDs coming through the CREE community over the last decade and a half.

The PhDs that are currently underway continue this work in important directions. One crucial angle is a critical take on curriculum, and Renee Smit, an ADL from electrical engineering, is starting to identify the specific logics that underpin engineering science courses, as opposed to the natural science courses that students encounter at the outset of these programmes.

Nicky Wolmarans, ADL in civil engineering, is also focusing on curriculum, but her study focuses on how the intrinsic logic of engineering design courses runs counter to the logic of engineering science, generally established earlier on in the programme.

Environmental and Process Systems Engineering

Professor Harro von Blottnitz
Adjunct A/Prof P Notten
Dr Adeniyi Isafiade
Honorary Professor Jim Petrie
Carol Carr

Description of activities

This is a multi-faceted research group with a 20+ year history of employing its process and systems engineering skills to develop knowledge and methods in response to the challenges of pollution prevention and sustainable development. Team members have worked in clean technology and cleaner production, waste management (municipal and industrial), industrial ecology, process design and integration, as well as process safety. It is well networked into a range of other disciplines on campus, both through inter-disciplinary postgraduate programmes and through research relationships.

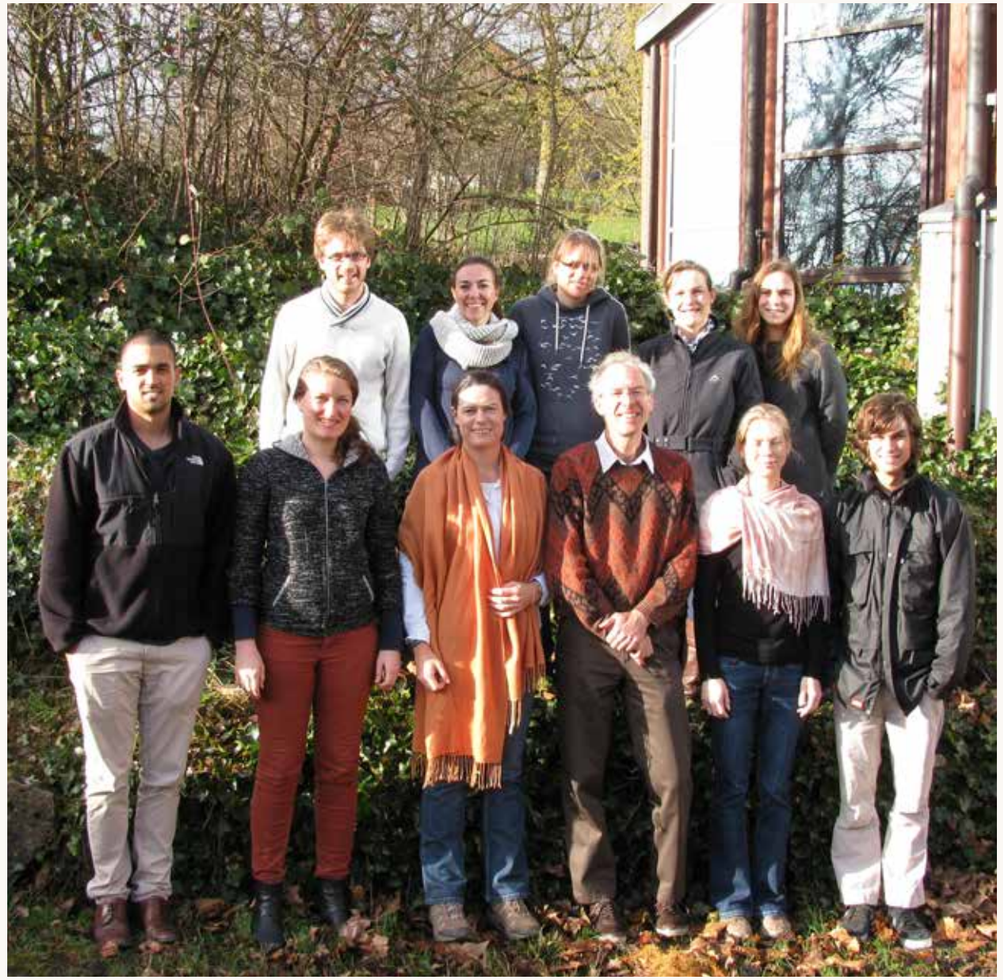
The unit believes that our country and our continent needs development, but also that the model of the 20th century industrial economy can be neither a goal nor a path for such development. Much radical innovation and large improvements in efficiency are needed. To this end, it engages with the diverse worlds of process design teams, environmental consultancies, corporate sustainability Departments, municipal engineers and managers, and regulators and programme directors in government. Their challenges are to spot opportunities for needed change, back them with efficient technology and steer their organisations to make tangible contributions to sustainable development.

Postgraduate research

The education of Masters and PhD students is a key component of E&PSE's research. Since sustainable development increasingly requires graduates with an ability to work across disciplinary fields, Prof von Blottnitz regularly also supervises postgraduates from outside the Chemical Engineering Department. Achievements of the postgraduates who completed their dissertations in the E&PSE group in 2015 include:

- Ms Melissa Sikosana showed that the most cost effective way for municipal waste water treatment works to achieve the phosphate discharge standards is by recovery of a crude struvite byproduct for fertiliser markets. Chemical precipitation yielding a waste to be disposed of is more costly. She did her research within a WRC-funded project and obtained an MSc.Eng.
- Mr Timothy Magezi studied the emergence of processed and packaged foods in African cities and showed how pre- and post-production wastes will change with a shift from the market to the supermarket. He obtained an MSc.Eng.
- Mr Paul Hoekman developed the first quantified urban metabolism for an African city when he managed to track down all major inputs and outputs of the city of Cape Town. He obtained an M.Phil. in environmental management from the Faculty of Science, with distinction.
- Ms Takunda Chitaka became the first M.Phil. graduate specialising in sustainable mineral resource development. In her dissertation, she studied whether there should be export restrictions on steel scrap collected in South Africa. She showed that policy interventions should be based on a nuanced understanding of how market dynamics and international competition matter differently in coastal vs. inland locations of collectors and foundries.
- Ms Joanne Crimes assessed different options of pre-treatment technologies for bioethanol production using multi-objective optimisation involving economics and environmental impact. Her study showed that pre-treatment options involving delignification should also include recycling of sodium hydroxide in order to have a profitable process. She also showed that acid-catalysed steam explosion with acid hydrolysis was one of the most profitable pre-treatment options with relatively low environmental impact. Ms Crimes study is part of the advanced bio-energy optimisation project funded under the competitive NRF grant for rated researchers.

E&PSE group members and some Swiss partners of the SAFARI project



Minerals to Metals Initiative

Since its establishment as a university Signature Theme in 2007, the Minerals to Metals Initiative (MtM) has moved minerals beneficiation research in the Department of Chemical Engineering and at UCT from a narrow focus on separate extraction processes to a novel holistic view of the entire minerals beneficiation chain, with a strong emphasis on sustainability. This has been done by forming exciting new trans-disciplinary staff collaborations and innovative inter-disciplinary research, based on strong scientific and technical foundations, allowing new knowledge creation both in fundamental science and in integrative systems thinking.

This approach is laying the platform for moving the minerals industry into a more sustainable paradigm. Considerable financial support for this effort has come from the SARChI Chair in Minerals Beneficiation, which was granted to the Director, Prof J-P Franzidis, in 2007. With Prof Franzidis's retirement at the end of 2014, the MtM entered into a transition phase in the course of 2015, Dr Jenny Broadhurst took over the role of director, whereas A/Prof Jochen Petersen became the acting SARCHI Chair. An excellent successor to Prof Franzidis was found in Prof Dee Bradshaw, who was formally appointed at the end of 2015, but participated in the Initiative's activities since September 2015.

Inter-disciplinary research

The continually evolving research programme, which falls under this umbrella body is underpinned by a number of industry-based projects and case studies, which together explore the sustainability challenges facing the minerals sector from both a systemic and fundamental perspective, and serve to establish linkages between traditional separate but cognate research areas.

Systemic research projects are concerned with the performance of minerals processing and beneficiation systems as a whole, and their interface with the environment and society. Examples of systemic research themes include acid mine drainage mitigation, deriving added value from mine waste, tools for holistic evaluation and optimisation of mineral systems, energy efficiency and minimisation of carbon footprint, water usage and degradation, mine safety and mine-community stakeholder engagement. Fundamental research projects are aimed at developing an understanding of the underlying physical and chemical principles that govern processes within the minerals beneficiation chain and the interactions with or impact on the remainder of the system. Fundamental, cross-cutting themes include positron emission particle tracking, electrochemistry, turbulent multiphase processing, rheology and ion-exchange. Thus research is aimed not only at increasing the amount of mineral or metal extracted from ores, but also at reducing the environmental and social impacts of mineral beneficiation operations.

In 2015, the MtM student cohort comprised six PhDs and 23 Master's-level students (4 MSc (Eng), 18 MPhil specialising in Sustainable Mineral Resource Development (SMRD) and 1 MPhil in Politics, Philosophy and Economics (PPE)). These students were supervised by a total of 15 UCT academics, including academics from the Department of Social Anthropology, Faculty of Commerce, the Energy Research Centre and the Department of Physics. Six masters' students were awarded their degrees and graduated during the course of the year. Graduates included the initiative's first MComm and MPhil (SMRD) graduates. MSC (Eng) students Mpendulo Ncongwane and Bridget Fundikwa were winner and runner-up respectively for Outotec's 2015 *Sustainability in the Minerals Industry* awards.

Postgraduate education and training

2015 saw the enrolment of the second cohort for the trans-disciplinary and inter-institutional Master of Philosophy Programme specialising in Sustainable Mineral Resource Development (SMRD), which was developed by Minerals to Metals academics as part of the Education for Sustainable Development in Africa (ESDA) initiative of the United Nations University Institute for Sustainability and Peace. This brought the total of number of students undertaking this programme in 2015 to 33, 21 of whom were registered at UCT and 12 at the University of Zambia (UNZA). This student body comprised one economist, one social anthropologist, four geologists, two lawyers, six mining engineers, four foresters, six chemical engineers, one geographer, three social scientists, one civil engineer, one psychologist, one mechanical engineer, one business analyst and one mineral processing engineer.

During the course of 2015, the second cohort of students completed four taught courses: Sustainable Development at the University of Stellenbosch; Strategic Social Engagement at the UCT Graduate School of Business; Environmental Stewardship at the University of Zambia; and Research Methodology at the UCT Department of Chemical Engineering. One student form the first cohort graduated at the end of 2015, with the remaining students expected to graduate during the course of 2016.

MtM, with support from the South African Minerals to Metals Research Institute (SAMMRI), also hosted the fourth national hydrometallurgy workshop and student research symposium between 24 and 26 August 2015, at UCT. The workshop, which was run by Professor Mike Nicol of Murdoch University, was devoted to fundamental concepts in hydrometallurgy, and was attended by 20 students from UCT, Northwest University, and the Universities of Pretoria, Stellenbosch and the Witwatersrand.

Minerals beneficiation strategy development

This past year also saw the continuation of the research project commenced in 2013 to develop a minerals beneficiation strategy for the KwaZulu-Natal province.

The three-year programme is funded by the KwaZulu Natal Department of Economic Development, Tourism and Environmental Affairs to the tune of R1.5m per annum, and is being carried out in collaboration with The Green House, a niche consultancy in sustainability and environmental management. The project is supported by four post-graduate research projects, one in the chemical engineering Department, one in the commerce faculty and two in humanities- further extending the interdisciplinary of the Signature Theme.

Stakeholder engagement

In line with its mission to promote collaborative and multi-stakeholder research and development, Minerals to Metals continued to engage actively with the public sector, civil society and the industry sector during the course of 2015. In July 2015, the acting director attended the Forum for Sustainable Development Indicators for the Mining Industry in Canada, participating in the formulation of the Milos Declaration for mining professionals.

Engaged scholarship, whereby knowledge is co-produced with non-academic constituencies, is central to many of the research projects that were undertaken during the course of 2015. These projects entailed research pertaining to the barriers, drivers and opportunities for the 're-purposing' of mine waste; the mine-waste-environment-community nexus; multi-stakeholder business models for downstream mineral beneficiation; integrated approaches for effective characterisation of ARD risks; and entrepreneurship in mining communities. In addition to these research projects, four of the MPhil students undertook short internships with external organisations, including the Royal Bafokeng Nation (an NGO), Anglo American (mining house) and The Green House (a niche sustainability consultancy). During these internships, students gained experience in the practice of sustainable development in Africa, while making a useful contribution to the host organisations.

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Safety and risk management

The Department of Chemical Engineering is conscious of the many occupational health and safety (OH&S) risks in its extensive laboratories, as well as the importance placed on SHE (Safety, Health and the Environment) in the industries that employ our graduates. The Department has worked hard to ensure that a 'no harm ethos' permeates the operations, both in teaching and research.

OH&S in laboratories and the workplace

The Department has a formal safety structure consisting of safety officers – typically head of research groups, safety representatives who are usually senior laboratory staff involved in the day-to-day monitoring and implementation of safety issues, as well as evacuation marshals, first aiders, a fire officer and a Hazchem co-ordinator. The Department hold quarterly meetings and inspections, in addition to a compulsory safety induction for all staff and postgraduate students

Safety in the curriculum

Safety permeates the undergraduate curriculum as a theme, with one course in each year using safety moments to build a habit of thinking of risk. OH&S is formally integrated into final year courses.

Safety training

The Minerals to Metals Initiative co-ordinates the South African sector of the Global Minerals Industry Risk Management (G-MIRM) Programme. Developed in Australia, it aims to increase safety by improving managers' understanding and practice of risk management thereby entrenching risk management in organisational culture.

Research in safety and risk management

Allied to the G-MIRM training activities, collaborative research in Safety Risk Management in the minerals industry was recently initiated. The first master's dissertation in this field has been completed and plans are underway to admit more postgraduate students to continue research in this area.

No harm ethos

The Department's vision is to be Africa's leading chemical engineering Department, through teaching and research. Safe and healthy learning and work places are indispensable to this vision. By practising what is known to be right, the Department can be an enabler of low risk, healthy, non-polluting, resource-efficient industrial production. Five cardinal rules that faculty and students pledge to know and obey encapsulate the measures in place to achieve this vision.

Cardinal safety rules
Proactive and outspoken – showing concern for safety and others
No work without safety thinking, planning and documentation
Barriers between people and risks, especially chemicals
Gases require advanced safety systems
Always ready for an emergency – evacuation without question