Annual Report 2020

Department of
Chemical Engineering

CENTENARY EDITION

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Contents

OUR **VISION 2022**

STAFF & STUDENTS

- Our students are professionals and future leaders.
- Our staff are passionate, committed and caring.
- Our diverse academic staff are respected leaders in their field.

OUR ENVIRONMENT

- The Department of Chemical Engineering is a vibrant, exciting, fun place to work.
- There is time for creative and original thinking, innovation and inspiration.
- With our home at the University of Cape Town – an Afropolitan university – we are a hub for high-achieving African and international scholars.

OUR ACHIEVEMENTS

- Our BSc, MSc and PhD graduates are independent thinkers.
- Our graduates recognise the needs of society in general and those of South Africa in particular.
- The Department focuses on innovation in technology, processes and research.
- We are experts in the transformation of the resource-based economy and in waste and water treatment.
- Our internationally recognised research excellence has helped us to rise to global research challenges that have particular local relevance.

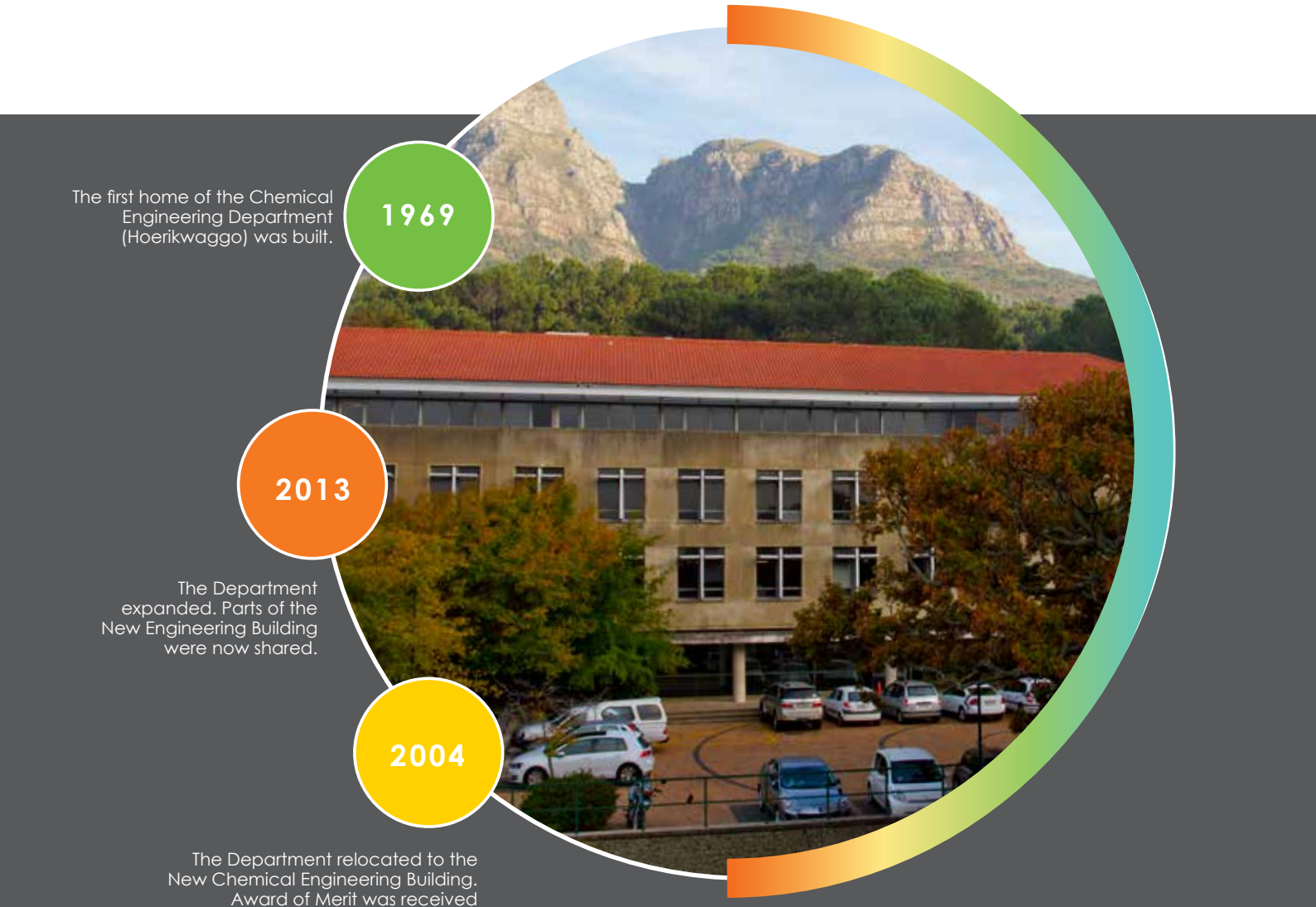
THE HISTORY OF **CHEMICAL ENGINEERING**

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 is a UNESCO World Heritage Site.

The first home of the Chemical Engineering Department – constructed 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 structural modifications, the increased number of students, coupled with a substantial increase in research activity, meant that we outgrew the building. Thus, in 2004, the Department relocated to the much larger New Chemical Engineering Building, which won an Award of Merit from the South African Institute of Architects for its design.

At the 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 10 years (by 2014). In 2013, in response to continued growth in both the undergraduate and the postgraduate programmes, the Department expanded further, and we came to share parts of the New Engineering Building with the Department of Civil Engineering, the Faculty Office and the new Centre for Imaging and Analysis.

Our undergraduate body has continued to grow to such an extent that most lectures now take place in the new Snape Teaching and Learning Facility.



PROFESSOR AUBREY MAINZA
HEAD OF DEPARTMENT

FOREWARD

THE COVID-19 PANDEMIC THAT AFFECTED THE WHOLE WORLD BROUGHT ABOUT UNPRECEDENTED CHALLENGES FOR THE 2020 ACADEMIC YEAR.

Globally, governments introduced lockdowns to prevent the spread of the virus, and this brought unique challenges for research and teaching programmes in the department and the entire university. Research activities that required the use of laboratory facilities were halted for five months starting on 27th March when the President of the Republic of South Africa announced the lockdown measures instituted by the government. Only activities aimed at maintaining the reactors that could not be stopped because they support organisms such as rare species of bacteria were allowed. General laboratory research activities were only allowed to resume at the beginning of September when signs that the first wave of the Covid-19 pandemic was receding. Face to face teaching activities stopped and academic staff used the five weeks of hard lockdown to prepare lecture material for remote delivery.

Teaching activities resumed in June with all lectures and assessments migrated to remote online mode. Study packs were prepared and delivered for a small number of students who were unable to access learning materials online.

Despite all the challenges the world faced as a direct result of the Covid-19 pandemic, the department had much to celebrate in 2020. A significant number of publications were produced, and awards were presented to some staff members and students in recognition of their contributions in different areas of research and social responsibility endeavours both locally and internationally.

This was impressive because most of the work was done remotely, converting teaching material into appropriate online lessons. The department also achieved a record number of students in the graduating class of 2020.

When the call to resume on-site research activities was made, the department was the first Engineering department at the University to return to campus. Staff and postgraduate students worked hard to put measures in place to prevent the spread of Covid-19 to facilitate the return to on-site research.

The year that presented lots of challenges closed with the Centenary celebration for the department. The occasion was fittingly celebrated with just over 70 people in attendance at one of the University venues where the function was held and thousands watching online. The people, both in the venue and the virtual platform, comprised current and past staff members, collaborators, students pursuing studies in the department, and alumni. The key milestones in the life of the department were captured in the book "A Century of Chemical Engineering at UCT ." The book was compiled and edited by Professor Jim Petrie and Professor Jenni Case, with contributions from collaborators, alumni, current students, and staff members both past and present.

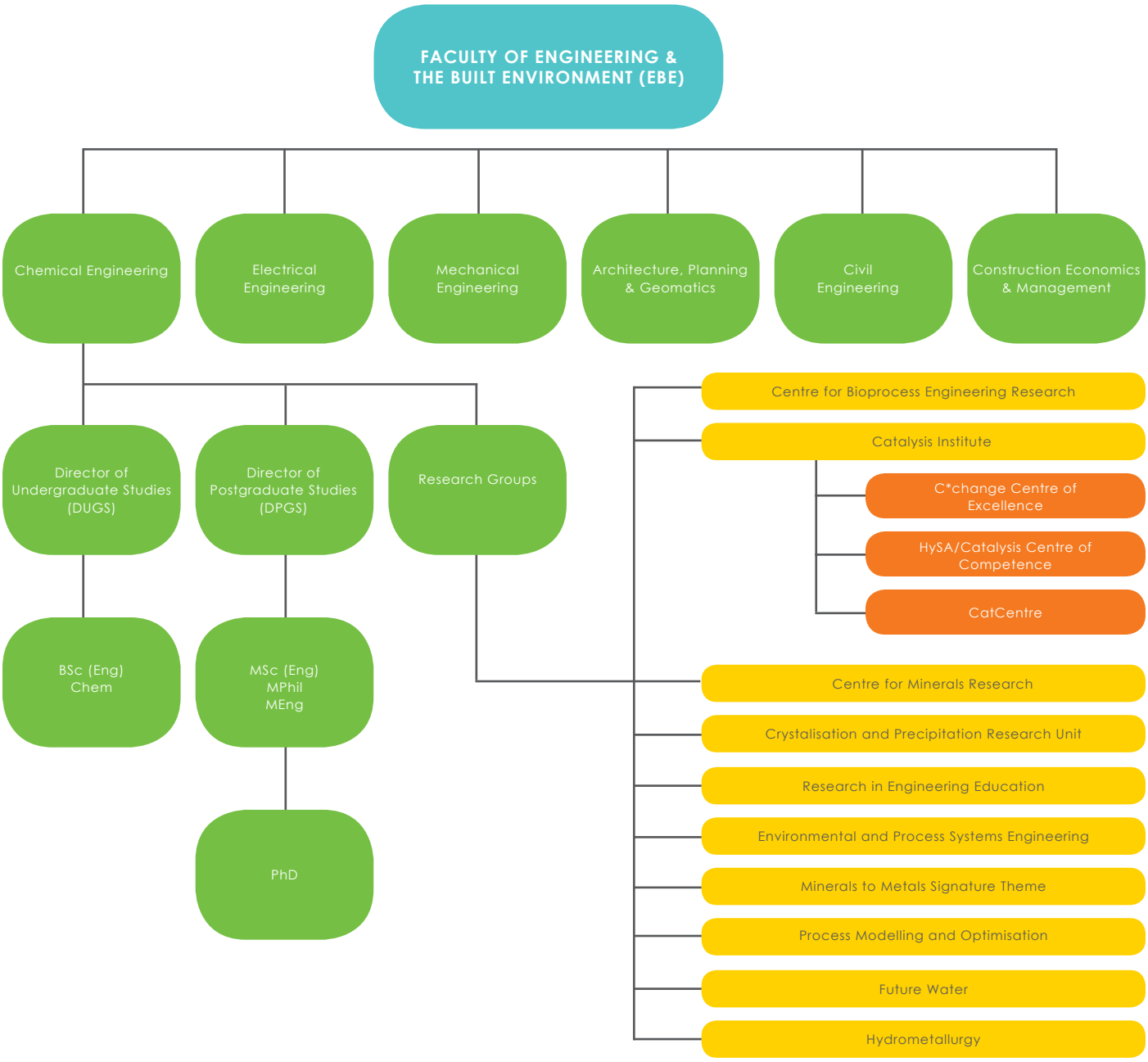
UCT
Centenary Celebration

The Department

THE **DEPARTMENT**

The Department of Chemical Engineering at UCT is one of six departments in the Faculty of Engineering and the Built Environment; the others being the Departments of Civil, Electrical and Mechanical Engineering and the Department of Architecture, Planning and Geomatics; and the Department of Construction Economics and Management. The Department offers a four-year BSc (Eng) (Chemical Engineering), as well as master's and doctoral degrees. The Department has recently restructured its undergraduate BSc (Eng) degree, with a strong focus on integrated project work with a strong theoretical underpinning, ensuring a relevant study to take on the challenges of the 21st century.

The MSc (Chem Eng), MPhil and 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 credits dissertation). The Department of Chemical Engineering also has strong research activity, as evidenced by the number of university-accredited research groupings hosted by the Department and its research output in accredited journals, as well as the large number of registered postgraduate students.



FACILITIES AND **EQUIPMENT**

THE DEPARTMENT RUNS AN ANALYTICAL LABORATORY, AN ELECTRONICS WORKSHOP, A MECHANICAL WORKSHOP AND AN EXPERIENTIAL LEARNING FACILITY.

ANALYTICAL LABORATORY
The Analytical Laboratory has a dedicated 4-member Team to provide analytical and material characterization services to the Department of Chemical Engineering, other departments at UCT, as well as other Universities and small-medium companies. The laboratory is equipped with an ICP-OES and MP-AES for the analysis of metals in solution, and a microwave digester for the acid digestion of powder samples. The laboratory also houses a Mastersizer and Zetasizer for particle size analysis, and a rheometer for rheology experiments. Other equipment includes a TriStar for surface area and pore size/volume measurements, ASAPs for chemisorption, AutoChems for temperature-programmed studies. The Analytical Team is also responsible for co-ordinating waste disposal for the research groups/labs in the department, as well as assisting with gas orders for instruments and specialised experiment setups.

ELECTRONICS WORKSHOP
The Electronics Workshop provides technical support to research groups and postgraduate students in the field of electronics, embedded systems, instrumentation and software design. It also runs several Linux servers that host molecular modelling (Accelrys, VASP), Computational Fluid Dynamics (Fluent) and Finite Elements (Abaqus) software that is used in departmental research. In addition to this, the workshop advises staff and students on the conceptual design of instrumentation, data acquisition and control systems for test rigs, and implements and commissions these systems. Furthermore, the workshop designs, builds and commissions custom electronics and software solutions are 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. Digital fabrication and rapid prototyping using 3D-printing technologies are also offered.

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

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 direct 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 the 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 this 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.

Safety, health and the environment are key features 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. These are skills 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 in building awareness of the role of engineers in technology development and testing.

DEPARTMENTAL FACILITIES
The Department of Chemical Engineering consists of several research groups with a variety of instrumentation. The facilities offered to students and researchers support research and teaching in the Department and at the University of Cape Town. These are facilities and analysis options that can be catered for within the Department. Liquid and gas chromatography is performed using various detection methods such as UV/VIS or RID for liquid chromatography, and FID, TCD or MS-detection for gas chromatography. Furthermore, two-dimensional GC analysis is performed using GCxGC with TOF-MS.

In addition, the Department of Chemical Engineering 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 in solid materials at elevated temperatures and pressures). A variety of reactors are available at the Department for testing biological reactions (fermenter, airlift reactor), heterogeneously catalysed reactions (fixed bed reactors, slurry reactors, Berty reactor), catalyst for fuel cells (fuel cell stations), crystallisation processes (Eutectic Freeze Crystallisers and LabMax crystallisers) and precipitation reactions (multiphase stirred tank reactors, fluidised bed crystallisers and large-scale (100L) multiphase reactors), crystallisation processes (Eutectic Freeze Crystallisers and LabMax crystallisers) and precipitation reactions (multiphase stirred tank reactors, fluidised bed crystallisers and large-scale (100L) multiphase reactors).

SAFETY & **RISK MANAGEMENT**

The Department of Chemical Engineering is cognisant of the many occupational health and safety (OHS) 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. We continually strive to instil a 'no harm' ethos in both our teaching and research operations.

OHS IN LABORATORIES AND THE WORKPLACE
The Department has a formal safety structure consisting of safety officers, typically heads of research groups, and safety representatives, usually senior laboratory staff involved in the day-to-day monitoring and implementation of safety issues, as well as evacuation marshals, first aiders, a chief fire officer and a Hazchem co-ordinator. We hold quarterly meetings in which laboratory inspections and incidents are reported and present a compulsory annual safety induction to all staff and postgraduate students.

SAFETY IN THE CURRICULUM
Health and safety permeates the undergraduate curriculum as a teaching strand, and our courses frequently hold safety sessions to teach students to build the habit of conducting risk assessments. OHS is formally integrated into final-year courses.

SAFETY TRAINING
The Minerals to Metals Initiative coordinates 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 it 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 is ongoing. This is primarily addressed by postgraduate dissertations with safety as a key area of focus, with students increasingly being encouraged to incorporate all appropriate safety considerations as part of their research.

'NO HARM' ETHOS
Our vision is to be Africa's leading chemical engineering department, through teaching and research. Safe and healthy learning environments and workplaces are indispensable to this vision. By teaching and practising current appropriate safety standards, we can be enablers of low-risk, healthy, non-polluting and resource-efficient industrial production. The five cardinal rules that we pledge to know and obey, which encapsulate the measures in place to achieve this vision, are as follows:

cardinal safety rules

1. Be proactive and outspoken - show concern for safety and for others.
2. No work without safety planning, thinking and documentation.
3. Form barriers between people and safety risks, especially chemicals.
4. Gases require advanced safety systems.
5. Always be ready for an emergency - evacuation without question.

The Programmes

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 Humanities. Approximately 110 students (from a diverse range of backgrounds) enter the programme each year (Figure 1).

Of these, approximately 25% voluntarily transfer into the five-year (Aspect) programme after the first term, i.e. 75% remain in the four-year (Mainstream) programme. The students in both programmes are supported through a variety of measures, including: a first-year mentorship scheme and team-building camp; dedicated year-advisors; 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 together with the rollout of a new curriculum from 2014 have enabled the department to produce an average of just over 106 graduates per annum over the past five years (Figure 2). The cohort that graduated in 2020 was the fourth cohort in the new curriculum and 69% of students graduated in minimum time. This year also marked the highest number of students graduating, with 116 receiving their degree in the winter 2021 graduation ceremony. Of these, we graduated 12 First Class Honours, and 43 Honours students. Of the 12 graduating with a First Class Honours, 6 come from the Aspect programme and is highlighted as a significant achievement for the programme.

The UCT Chemical Engineering undergraduate programme works closely with industry. 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.

OVERALL INTAKE: 2009-2020

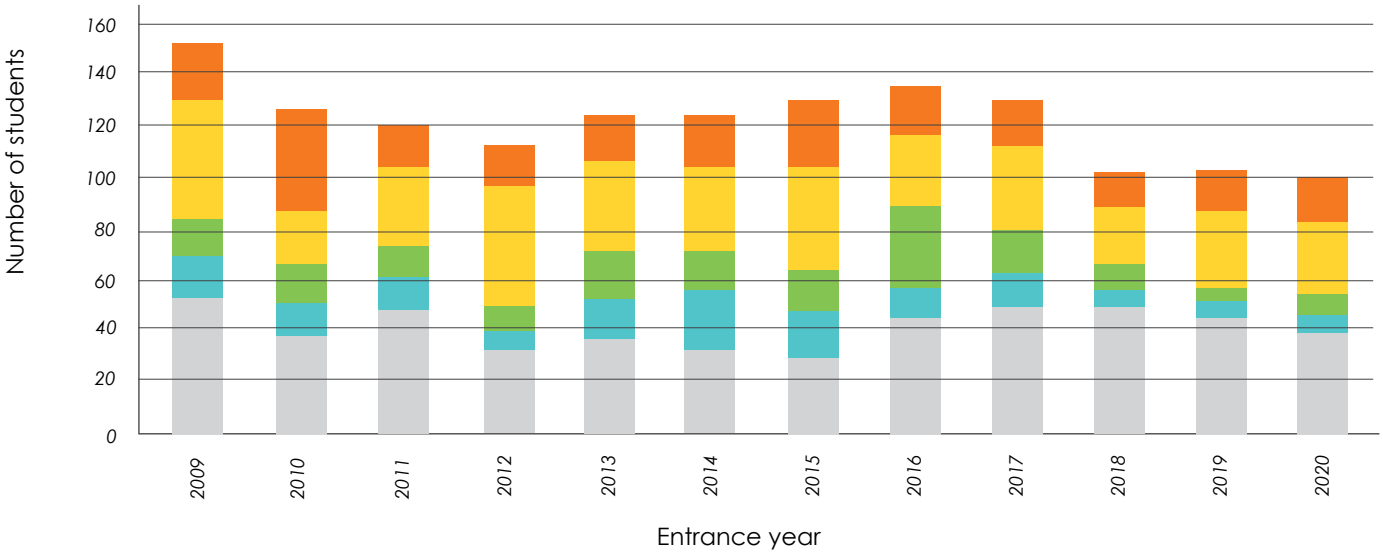


Fig 1: Overall intake between 2009 and 2020 by population group

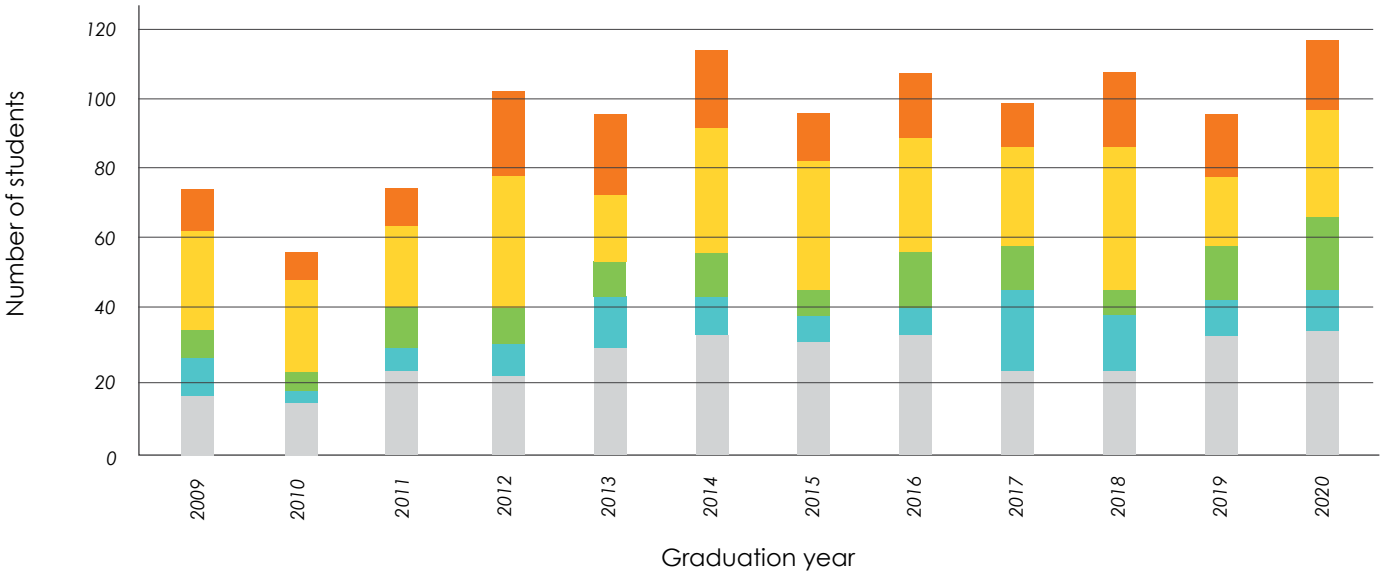


Fig 2: Number of graduates from the programme between 2009 and 2020 by population group

BSC CHEMICAL ENGINEERING GRADUATES (116) IN 2020

Abrahams, Muhammad Nabeel	
Adeyemi, Adedolapo Susannah	Honours
Akhalwaya, Abdullah	
Alur, Chinmaya	
Badenhorst, Eunickah Ruth	
Brockwell, Jamie Bowker	Honours
Boyce, Kevin Michael	
Chauke, Ntsakisi Khutazani	Honours
Chen, Wesley	
Chetty, Myron Alistair	
Chaza, Nyika Mufudz	
Class, Siphosethu	
Confait, Luke Andre	Honours
Crosson, Courtney Mary	Honours
Casse, Taylor Duncan	
Debeil, Leonard Daniel	Honours
Douglas, Roxanne Seonaid	Honours
Dooki, Joshan	First Class Honours
Diseko, Mathe Loatile	Honours
Douwie, Brandon Michael	Honours
Daya, Chad	
Francis, Rusheil	
Fortuin, Abigail	Honours
Gibbons, Lucy Pola	
Golding, Matthew	Honours
Galela, Tineo	
Glover, Kelly Leigh	First Class Honours
Gambara, Tinotenda	
Gangat, Zakariyya	
Gosain, Mogamad Yaameen	
Govender, Kavesh	

Haider, Syed Mohammed	Honours
Hudson, Jessica Claire	Honours
Hlongwane, Langa Thembinkosi	
Hambrock, Philip	First Class Honours
Hansraj, Tiana	First Class Honours
Herrington, Sarah Jean	Honours
Hartzenberg Aeroe, Ellen Katherine	First Class Honours
Isaacs, Tasneem	Honours
Jacobs, Mohamed Natheer	
Jhugroo, Anshikha	Honours
Jali, Thando	
Jowah, Tomutenda Godfrey	Honours
Jiawain, Megan	Honours
Jwara, Siphesihle	
Khan, Saahil	Honours
Kelesitse, Mosimanegape Fangos	
Kantor, Tyler Stephan Lewis	Honours
Kruger, Christian Martin	
Kistnasamy, Mohamed Taariq	
Ketlogetswe,Oaitse Percy	
Lottering, Abdul Malik	
Mbaba, Ongezwa	Honours
Mccann, Josephine Amy	Honours
Mudau, Franklin Dakalo	
Mudau, Lufuno	
Mafunda, Ayanda	Honours
Mgoduka, Sibulele Sinazo	First Class Honours
Mohidin, Nailah	
Mahomed,Mubeen	
Makhubela, Thabelo Noluvuyo	
Molefe, Boitumelo Daisy	
Mulla, Abdulla Suleman	First Class Honours

Mngqibisa, Elihle Khonaye	Honours
Munguma, Willie Garikai Geneous	
Mneno, Dumile Peabo	
Munro, Tiaan	Honours
Mashungupa, Vongai	Honours
Musselwhite, Laragh Anne	
Mistry, Nikhil Nilesh	Honours
Moos, Safiyyah	
Mothibi, Omphemetse Phemi	
Motlhabi, Tlotlo Letlhogonolo	Honours
Mutepaire, Liberty Tafadzwa	Honours
Mvunelo, Nolita Thina	Honours
Ndlovu, Ronaldo Siyabonga	
Naidu, Narian Moneau	Honours
Njagi, Virginia Karimi	Honours
Njozela, Sazi	
Nkabinde, Menzi Don	
Nkomo, Kwazinkosi Rethabile	
Nondonga, Phendulwa	
Phiri, Manase	
Pillay, Anisha	
Pather, Radhia	
Payne, Eric Joseph Roberts	First Class Honours
Payne, Mikaela Lana	
Raeburn, Yael Lauren	Honours
Radebe, Londeka Praiseworth	
Rodgers, Brendan Charles	
Rogers, Jessica Leigh	Honours
Rogers, Natalie Kate	Honours
Rakotondrainy, Manohiaina Evy	
Ramaisa, Keketso Jacob	
Ramsamy, Saientha	
Rustomjee, Cesar Godrej Rustom	
Reeves, Christie Tamryn Puttenham	
Sibisi, Funokwakhe	
Shilaluke, Sundani Nompumdlelo	
Shava, Brian Ngonidzashe	
Sinjani, Taonga Mchirwa	Honours
Sithebe, Nhlanhla Simphiwe	Honours
Stander, Brigitte Elisabeth	Honours
Steyn, Tobie	First Class Honours
Themane, Neo	
Tenderini, Natasha Leigh	Honours
Tarboton, Bianca	First Class Honours
Turner, Harold James	
Tshaka, Simthembile	
Whitfield, Colin Taylor	First Class Honours
Wan, Kylie Kin-Lam	First Class Honours
Zimmermann, Samuel Gunther	
Zondo, Nondumiso Nontobeko	Honours
Zunguza, Dumisani Jerry	Honours

POSTGRADUATE **PROGRAMME**

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

The Department offers a PhD and a research only MSc (both by dissertation), a taught MSc and a taught MPhil (both by coursework and dissertation) degrees. The PhD and MSc degrees may be carried out in any of the following research areas: bioprocess and catalytic process engineering; crystallisation and precipitation; environmental and process systems engineering; minerals processing; hydrometallurgy and process modelling.

The MSc, through a combination of coursework and research is offered in the areas of bioprocess and catalytic process engineering. The Mphil degree, specializing in Sustainable Mineral Resource Development, is trans-disciplinary and is offered through the Minerals to Metals Research Initiative within the department. All postgraduate studies based in the Department of Chemical Engineering involve a substantial research project in the context of larger research programmes. The Department prides itself on the availability of modern, world-class research facilities for postgraduate studies. All postgraduate students are required to undertake the course on Research Methodology and Communication (CHE5055Z), leading to the formulation of a detailed research proposal. For PhD students, the proposal is presented in a seminar to the Department and reviewed by a panel comprising three academics, before registration is finalised by the Doctoral Degrees Board.

In 2017, a detailed cohort analysis covering the years 2005 to 2016 was conducted to evaluate the progress of postgraduate students. Total enrolment was in the order of 160 to 180 postgraduate students in recent years, of which around 45% are now PhD students. While a 'steady state' between intake and graduation has been achieved with MSc students, the PhD cohort is still growing. Concerns relating to MSc students taking relatively long to graduate and a significant rate of discontinuation among PhD students have been identified and are being addressed.

MASTERS CHEMICAL ENGINEERING GRADUATES (13) IN 2020

Collair, Wesley	MSc (Eng) by dissertation (with distinction)
Dlamini, Reuben Mkhulek	MPhil
Gibson, Borbor	MSc (Eng) by dissertation (with distinction)
Guseva, Olga	MSc (Eng) by dissertation
Harrisanker, Naomi	MSc (Eng) by coursework and dissertation
Harrison, John Derrick	MPhil
Hill, Herbert Edward	MSc (Eng) by dissertation (with distinction)
Labi, Tita Ntow	MSc (Eng) by coursework and dissertation (with distinction in the coursework component)
Mehlo, Brenda	MSc (Eng) by dissertation
Prestele, Mark Patrick	MSc (Eng) by dissertation (with distinction)
Rajan, Ziba Shabir Hussein Somjee	MSc (Eng) by coursework and dissertation (with distinction in the dissertation)
Tetlow, Sarah Frances	MSc (Eng) by dissertation
Turan, Evren Mert	MSc (Eng) by dissertation (with distinction)

PHD CHEMICAL ENGINEERING GRADUATES (5) IN 2020

Chitaka, Takunda Yekai	PhD
Gambu, Gorden Thobani	PhD
Hessler, Tomas	PhD
Marais, Tynan Steven	PhD
Tucker, Chelsea Lyn	PhD

The Research

NOTEWORTHY **NEWS**

100 YEARS AT CAPE TOWN

Jim Petrie and Jenni Case celebrate a centenary of Chemical Engineering

Chemical Engineering at the University of Cape Town (UCT) celebrated its centenary in December 2020 – the first university in Africa to do so, and, by our records, second only to the University of Queensland across the Southern Hemisphere.

The Department showcased this occasion in a Covid-conscious celebration, allowing for a mix of live and virtual attendees. Close to 800 people dialled in from around the world. Invited speakers included representatives of the alumni diaspora down the years, as well as UCT's executive leadership and industry and research collaborators. The event also launched the book 2020: A Century of Chemical Engineering at UCT (pictured).

The monograph details the evolution of the programme; highlights key personalities who contributed their vision, energy and commitment to ensure that the programme succeeded and thrived; and showcases a range of personal vignettes from alumni, research colleagues and industry associates about their relationship with the department, its programmes and its people. At the same time, it attempts to develop an inclusive narrative which positions this story against the backdrop of South Africa's evolving social history, including its industry base.

The text describes how a small but agile chemical engineering programme has matured into a world-class entity, continuing to leverage its expertise to make a meaningful contribution to solving the critical problems of 21st century living. We believe there are signals and lessons here for other similar-sized departments around the globe on how to capitalise on their knowledge and alumni base and links to society at large.

CONGRATULATIONS

Congratulations to **A/Professor Nico Fischer** for being a recipient of the College of Fellows Young Researcher Award in recognition of his outstanding contribution to research and capacity development in his field.

The award is granted annually to young academics at UCT to support their demonstrated ability of making a significant contribution to their field and is intended for research purposes. The award is an encouragement to continue your outstanding scholarly achievements as a young researcher. We are privileged to work in the same department as A/Prof Fischer and benefit from his research and other contributions. It is nice to see his work being recognised at the University level.

DINAANE DEBUT FICTION AWARD

Resoketswe Manenzhe, a young lecturer and PhD candidate in the Centre for Minerals Research in the Department of Chemical Engineering received the 2020 Dinaane Debut Fiction Award. The R35 000 prize comes with a publishing deal from Jacana Media.

FUTURE PROFESSORS PROGRAMME

Dr Elaine Govender-Opitz from the Department of Chemical Engineering on being selected as one of the candidates for the Department of Higher Education and Training's Future Professors Programme. All 26 universities submitted nominations for the programme which were rigorously reviewed by a selection committee.

NATIONAL ACADEMY OF ENGINEERING

Professor Sue Harrison was elected as one of 18 international members to the National Academy of Engineering. She is one of just six from the African continent to be elected to the academy.

HEALTH SCIENCES

Professor Jack Fletcher and staff from the Catalysis Institute are working with a team in Health Sciences – led by Professor Keertan Dheda (Pulmonology) and Dr Sudesh Sivarasu (Biomedical Engineering) – to participate in a project to design, build and demonstrate (prototype) a device for the decontamination of N95 respirators (masks) used in medical facilities treating COVID-19.

TW KAMBULE-NSTF AWARD

Professor Jennifer Broadhurst was a finalist for the TW Kambule-NSTF Award: Researcher for developing integrated approaches for mitigating long-term environmental and associated social impacts in the primary mineral sector. Below are two links for write-ups on this award.

https://www.facebook.com/NSTFSA/posts/meet-our-finalistsprof-jennifer-broadhurst-research-director-department-dept-of-/3085697044880348/

https://www.news.uct.ac.za/article/-2020-06-12-six-uct-researchers-are-science-oscars-finalists

We also appointed two new researchers: Thandazile Moyo (research officer) and Cledwyn Magunda (Junior Research Fellow)

HAND SANITISERS TO GOOD USE

Thabiso Letlala, (BSc, chemical engineering), **Lebohang Mhlambi** (BSc, mechanical engineering) and **Nosipho Msimango** (BSc, chemistry and human anatomy and physiology), have designed a portable distillation vessel to make hand sanitisers. With sales of alcohol prohibited, the device puts surpluses to good use. The use of hand sanitisers has been widely recommended to counter the spread of the outbreak, now a pandemic and global public health emergency, according to the World Health Organization (WHO). The Corry Team's prototype, which mimics the design of a Grainfather, shows how breweries and distilleries can become producers of affordable hand sanitisers at a time of supply shortages.

NOTEWORTHY **NEWS**

GERMAN-AFRICAN INNOVATION INCENTIVE AWARD

Professor Jochen Petersen from the Department of Chemical Engineering is one of six scientists from Africa who received a German-African Innovation Incentive Award (GAIIA)2020. His partner is Professor Friedrich from RWTH Aachen University and their project VaReeWA is the development of a combined thermal pre-treatment and hydrometallurgical process route for Value Recovery from e-Waste through small-scale recyclers in Africa.

https://www.dw.com/en/urban-mining-in-south-africa/av-55734671

OPEN AFRICA POWER PROGRAMME

Carol Ngwenya, a PhD student in CeBER in the Department of Chemical Engineering, was one of three EBE students who were selected to attend the Open Africa Power programme in February 2020.

NATIONAL SCIENCE AND TECHNOLOGY FORUM (NSTF)

This year, two out of the six UCT finalists for the National Science and Technology Forum (NSTF) awards are from EBE. W Kambule-NSTF Award: Researcher: Professor Jennifer Broadhurst, Department of Chemical Engineering. Engineering Research Capacity Development Award: Associate Professor Abimbola Windapo, Department of Construction Economics and Management. Due to the COVID-19 pandemic, the awards gala dinner was a live-stream broadcast on 30 July 2020. A/Prof Windapo was announced as the winner of the Engineering Research Capacity Development Award.

AFOX-DIGITAL INSAKA

Professor Alison Lewis, Dean was the guest speaker for the Afox-digital insaka - a gathering for sharing ideas and knowledge about Africa-focused research with speakers from diverse and varied academic disciplines organised by the University of Oxford. Alison spoke on Universities of the Future.

AB INBEV BREWING INTERVARSITY COMPETITION

AB InBev Brewing Intervarsity competition – no prizes this year but given that UCT was largely operating at level 5 for 2020 the fact that we got two beers in was superb.

WASTE TO FUEL INITIATIVE

Waste to Fuel Initiative, a collaborative project under **Professor Eric Van Steen** in the Department of Chemical Engineering, and a research team spanning three continents (South Africa, Brazil and India), is an IChemE Global Awards 2020 finalist in the Energy category.

RESEARCH GRANT

Rhiyaad Mohamed, a researcher in the electrolyser group in HySA Catalysis in the Department of Chemical Engineering, has secured substantial funding from the German Federal Ministry of Education and Research (BMBF). The grant is in the range of €150 000 and will run for two years from August 2020.

MAIL & GUARDIAN'S TOP 200

Two EBE graduates and two EBE postgraduate student were named as one of the Mail & Guardian's Top 200. They were **Farirai Sanyika**, 2014 Chemical Engineering graduate; **Shaakira Chohan**, 2010 March (Prof) graduate; Ian Mangenga, honours landscape architecture student; and Thapelo Nthite Electrical Engineering master's student and chair of the EBE postgraduate student council.

POST GRADUATE CONFERENCE 2020

A Next Generation Resources Post Graduate Conference was organised by **Michael Odidi** and **Catherine Edward**. This was a student-run PG conference that focused on 'breaking silos' within the mineral resources research space. This was an international event, in collaboration between UCT, University of Queensland (SMI), University of British Columbia and the University of Exeter (Camborne School of Mines).

NATURE CATALYSIS JOURNAL

A team of former PhD students: Moritz Wolf (now Head of Team at the Helmhotz Institute Erlangen-Nuernberg, Germany), A/Prof Nico Fischer and Prof Michael Claeys (from the DSI-NRF Centre of Excellence in Catalysis c*change) has published a study on the deactivation of cobalt catalysts in the Fischer-Tropsch Synthesis in the prestigious Nature Catalysis journal.

AMAZON PUBLICATION

Gavin Fraser, a 1980 chemical engineering graduate, published a book, "The Moral Stress of Nations," on Amazon. It has reached no.3 in worldwide bestsellers for books about Colonialism & Post Colonialism.

INTERNATIONAL FALLING WALLS COMPETITION

Chelsea Tucker, a PhD candidate in the Department of Chemical Engineering, was chosen as one of the ten winners in the Emerging Talents category at the International Falling Walls Competition.

OTTER AFRICAN TRAIL RACE

Bianca Tarboton, a final-year student in the Department of Chemical Engineering, came second in the Otter African Trail Race. She managed to balance her training with her academic work and has been awarded a first-class pass for her design project.

OPEN AFRICA POWER PROGRAMME

The Royal Academy of Engineering has selected **Dr Mehdi Safari** as the Top Engager at Frontiers of Development in the area of resilient resource use. Mehdi is a postdoc in the Centre for Minerals Research in the Department of Chemical Engineering, where he is managing some commercial industrial projects.

ACADEMIC STAFF & RESEARCH FIELDS

NAME	RESEARCH FIELD
Mr Fadiel Ahjum	Techno-economic optimisation modelling applied to energy systems with a focus on integrated resource assessment (i.e. Water-Energy-Land systems); transportation systems and fuel supply; power systems; the hydrogen economy; in a context of cost-optimal sustainable and equitable development
Dr Lawrence Bbosa	Centre for Minerals Research, and the Minerals to Metals Initiative – Process mineralogy and applied mineralogy, geometallurgy
Associate Professor Megan Becker	Centre for Minerals Research, and the Minerals to Metals Initiative – Process mineralogy and applied mineralogy, geometallurgy
Dr Paul Bepswa	Centre for Minerals Research – Design of high-precision metal accounting measurement networks and investigations into the operational performance of tumbling mill comminution circuits
Dr Sharon Blair	Catalysis Institute – Director of HySA/Catalysis – Technology transfer
Dr Sherry Bremner	Centre for Minerals Research - Comminution research with a focus on modelling fine grinding technologies using computational and experimental techniques
Associate Professor Jennifer Broadhurst	Minerals to Metals – Sustainable development of mineral resources with specific focus on environmental issues
Dr Jessica Chamier	Catalysis Institute – Materials scientist developing and synthesising new materials for membrane electrode assemblies (MEAs) used in fuel cell design. We are focusing on the design, development and electrocatalytic evaluation of novel catalyst support materials as well as methods for catalyst deposition and impregnation
Professor Michael Claeys	Catalysis Institute – Director of DSI-NRF Centre of Excellence in Catalysis (c*change). Fischer-Tropsch synthesis, CO2 valorisation, development of in situ catalyst characterisation methods (e.g. XRD, magnetometry), nanomaterials
Associate Professor Kirsten Claire Corin	Centre for Minerals Research – Water in flotation, froth flotation, flotation and grinding chemistry, flotation electrochemistry
Professor David Deglon	Centre for Minerals Research – Computational fluid dynamics and flotation cell modelling
Ms Catherine Edward	Centre for Bioprocess Engineering Research - Inhibition kinetics of biooxidation organisms for process development and optimisation
Dr Marijke Fagan-Endres	Centre for Bioprocess Engineering Research – Fine bioproducts, primarily focusing on process development for production of probiotics and pigments; Biominerals, including heap bioleaching hydrology and bioflotation
Dr Mohamed Fadlalla	Catalysis Institute - Evaluation of heterogeneous catalyst formulations/systems for preferential oxidation of carbon monoxide, carbon monoxide and carbon dioxide hydrogenation to fuels and chemical, in situ and ex situ catalyst characterization
Associate Professor Nico Fischer	Catalysis Institute – Study and characterisation of heterogeneous catalyst systems for synthesis gas conversion reaction including CO2 activation processes with special focus on the development and application of in situ characterisation techniques
Professor Jack Fletcher	Catalysis Institute Director – hydrogen production, fuel processing, hydroprocessing and renewable fuels
Mr Armand Stefan Geldenhuys	Centre for Minerals Research – Flotation plant optimisation, modelling and simulation. Flotation froths. Laboratory measurement and scale-up for model development

NAME	RESEARCH FIELD
Professor Sue Harrison	DVC Research & Internationalisation. Director of the Centre for Bioprocess Engineering Research – Interaction of micro-organisms with the environment; microbial ecology and community dynamics in planktonic and sessile environments; energy-efficient reactor systems; biokinetics, metabolic modelling of biomass and bioproducts; and integrated bioprocess systems. The above is applied to the fields of alkane biotechnology, biomanufacture of pigments, enzymes and nutraceuticals, yeast handling, mineral bioleaching through heap and tank processes, acid rock drainage (ARD) prevention, ARD remediation through sulphate reduction, wastewater bioprocessing, algal bioprocesses for bioenergy and fine chemicals, bioprocess design, and evaluation for sustainable process engineering
Mr Hilton Heydenrych	Crystallisation 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
Ms Alison Hughes	Energy systems anlaysis- energy systems models, energy efficiency, sustainable energy access, load research
Associate Professor Adeniyi Isafiade	Environmental and process systems engineering and process modelling and optimisation – Bioenergy supply chain optimisation, process integration for materials, water and energy optimisation and systemic approach to mining accident causality
Professor Patricia Kooyman	Catalysis Institute - South African Research Chair Nanomaterials for Catalysis. Nanomaterials synthesis, advanced characterisation, and (catalytic) applications. Oxide nanoparticles, (alloyed) metal nanoparticles, (hierarchical) zeolites, sulphides, for use in: preferential oxidation of carbon monoxide in hydrogen, water-gas shift, selective methanation of carbon monoxide in hydrogen, Fischer-Tropsch synthesis, hydrocracking/ dewaxing, electro catalysis. Operando / in situ advanced transmission electron microscopy
Dr Thanos Kotsiopoulos	Deputy Director Centre for Bioprocess Engineering Research – ARD mitigation of abandoned mine wastes using permeable reactive barriers. Research extends to the advancement of new products through innovative bioprocess technologies with an emphasis on industrial application
Associate Professor Pieter Levecque	Catalysis Institute – Catalysts and components for polymer electrolyte fuel cells, photocatalytic water splitting
Professor Alison Lewis (Dean)	Director of the Crystallization and Precipitation Research Unit – Industrial precipitation and crystallization, recovery of value from effluent streams, water treatment through crystallization, process design and integration for water treatment, Eutectic Freeze Crystallization, Recovery of Rare Earth Elements, product and particle analysis; process analysis and control for optimised product quality; aqueous chemistry modelling of speciation, thermodynamic equilibria, hydrodynamic and population balance modelling of precipitation systems
Mr Niels Lüchters	Catalysis Institute – Fuel to hydrogen
Professor Aubrey Mainza	Centre for Minerals Research – Comminution and classification research; focusing on modelling of comminution and classification unit devices and using these in circuit design and optimisation studies
Ms Resoketswe Manenzhe	Flotation chemistry and reagent research and optimisation - Optimisation of in-situ surface analysis techniques in mine tailings reprocessing, analysis and optimisation of recycle water systems and their effects on lab-scale metallurgical processes

ACADEMIC STAFF & RESEARCH FIELDS

NAME	RESEARCH FIELD
Dr Malibongwe Manono	Centre for Minerals Research – Flotation reagents, flotation chemistry, water within minerals processing, and dewatering of flotation concentrates and tailings
Associate Professor Belinda McFadzean	Centre for Minerals Research – All aspects of flotation from interfacial interactions and chemistry to froths and full-scale optimization
Mr Bruno Merven	Energy Systems modelling using various platforms such as TIMES, LEAP, MESSAGE, GAMS, etc...at various scales (e.g. power-pools, national, regional, city, site), covering all energy commodities (electricity, liquid fuels, hydrogen, etc...). Linked Energy-Economy wide (Computable General Equilibrium) modelling. Energy Systems and Linked Energy-Economy wide modelling done in support of energy systems planning and policy making
Dr Disaapele Mogashana	Centre for Research in Engineering Education (CREE) – Engineering Education, Student Support, Student Success, Life Coaching, Higher Education
Dr Thebe Mokone	Hydrometallurgy - Focusing on metal extraction from secondary mineral ores and process development for industrial wastewater treatment
Dr Rhiyaad Mohamed	Catalysis Institute – Research and development of materials and components for low-temperature PEM electrolyser applications
Professor Klaus Möller	The research focus is about using novel implementations of open source simulation tools to develop custom simulations and analyses of industrial and conceptual processes. In particular the methodology used various combinations of Multi-species, Multi-phase, elementary kinetic models, thermo-chemical models, mass transfer models and heat transfer models to describe processes and operations. Multi-dimensional problems of regular geometry are solved using collocation, while problems with complex geometry are analysed using CFD via OpenFoam. These tools are used to develop custom solutions for a range of local industries, namely, the conversion of alcohols to distillates, novel Fischer-Trosch fixed bed reactors for wax production, plastic to diesel, novel PSA air separation designs, carbon black furnace, beer tunnel pasteuriser, greenhouse design for enhanced CO2. In each case the simulation aims to provide enhanced understanding, energy minimisation, environmental impact reduction and further innovation through knowledge
Dr Thandazile Moyo	Hydrometallurgy research, Urban Mining, Electronic waste recycling, Artisanal and Small-scale Mining (ASM) and Sustainable development
Mr Muven Naidoo	Centre for Bioprocess Engineering Research - Process Technologies for the Recovery of Biobutanol via *in situ and ex situ* Separation with a focus on optimising energy use and improving productivity
Dr Elaine Govender-Opitz	Centre for Bioprocess Engineering Research - Application and modelling of biohydrometallurgical processes for the treatment of primary and secondary resources. Recovery of economic value from waste streams towards a circular economy model. Assessment of the impact of post-mining transformation strategies on water-energy-food nexus
Professor Jochen Petersen	Hydrometallurgy, especially heap (bio)leaching of low-grade minerals, electrochemical study of mineral leaching kinetics in various chemistries (sulphate, ammonia, halides, cyanide), rare earth leaching, iron control, ion exchange and hydrometallurgical process analysis. Also holds the SARChI Chair in Minerals Beneficiation (since late 2018)
Ms Tokoloho Rampai	Physical metallurgy, pyrometallurgy, materials and polar engineering. Specialising in ceramics; hard materials and Antarctic sea ice
Dr Maximilian Richter	Numerical and analytical modelling of granular flows in comminution and classification, Particle tracking applications in granular flow systems
Dr Mariette Smart	Centre for Bioprocess Engineering Research - Fundamental research of biologically assisted metal recovery processes for improved performance. Influence of microbes on industrial processes. Biological value recovery from discard streams including pathogen removal and remediation of metals from wastes and waste waters. Rehabilitation of mine soils

NAME	RESEARCH FIELD
Dr Darija Susac	Catalysis Institute – HySA Catalysis Research and Technology Development Manager for Fuel Cells and Electrolysers. Physical chemist with expertise in materials development and characterisation for energy application. Development of new electrode structures and structure-property-performance correlations
Dr Siew Tai	Centre for Bioprocess Engineering Research - High-value bioproducts, vaccines and biopharmaceuticals, skin disorder & cosmeceuticals, upstream and downstream processing, techno-economics
Mr André van der Westhuizen	Centre for Minerals Research – Comminution and fine-particle processing
Ms Tracey van Heerden	Catalysis Institute – Investigating metal-support interactions on cobalt Fischer-Tropsch catalysts
Professor Eric van Steen	SA Research Chair in Reaction Engineering, Catalysis Institute – Fischer-Tropsch synthesis, catalytic oxidations, photo-catalysis, molecular modelling of heterogeneous catalytic systems and reaction kinetics
Professor Harro von Blottnitz	Energy and Industrial Systems Research – Industrial ecology, life cycle assessment, energy transition, 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
Mr Jason Waters	Centre for Minerals Research – Comminution and classification (including fine particles processing and rheology)
Dr Nodumo Nokulunga Zulu	Centre for Bioprocess Engineering Resarch - Algal biotechnology research towards nutraceutical and pigment production. Valorisation of waste streams for biogas production

EMERITUS STAFF

Emeritus Professor Cyril O'Connor	Centre for Minerals Research – Flotation; reagent studies
Emeritus Professor Jean-Paul Franzidis	SA Research Chair in Minerals Beneficiation & Director of Minerals to Metals Signature Theme – Integrating and expanding capacity in minerals beneficiation research
Mr Walter Böhringer	Catalysis Institute – Heterogeneous acid catalysis (core area) and hydroprocessing

ACADEMIC STAFF & RESEARCH FIELDS

NAME	RESEARCH FIELD
HONORARY STAFF	
Honorary Professor Jennifer Margaret Case	Centre for Research in Engineering Education – Student learning in science and engineering education, knowledge and curriculum, graduate destinations, higher education studies
Honorary Professor Paul William Cleary	
Honorary Professor Indresan Govender	Centre for Minerals Research – Particle Technology
Honorary Professor Christopher Hebling	Catalysis Institute – hydrogen technologies, electrolysers & fuel cells, photovoltaic (solar PV) systems & materials, wind energy. Currently the Director of the Hydrogen Technologies Division, Fraunhofer Institute for Solar Energy Systems (Germany)
Honorary Professor Graham Hutchings	Catalysis Institute – Heterogeneous catalysis, selective oxidation and hydrogenation, in situ spectroscopy, catalysis by gold, design of novel catalysts
Honorary Professor Michael Nicol	Hydrometallurgy
Honorary Professor Hans Niemantsverdriet	Catalysis Institute – Heterogeneous catalysis, surface science, fundamentals of synthesis gas chemistry, scientific leadership training
Honorary Professor Jim Petrie	Environmental and Process Systems Engineering – Decision support systems, sustainable energy systems, industrial ecology
Honorary Professor Neville Dennis Plint	
Honorary Professor Malcolm Powell	
HONORARY ASSOCIATE PROFESSORS	
Honorary Associate Professor Jo Burgess	Centre for Bioprocess Engineering Research – Water and mining
Honorary Associate Professor Brett Cohen	Environmental Engineering
HONORARY RESEARCH ASSOCIATES	
Honorary Research Assistant Dr Chris Bryan	Centre for Bioprocess Engineering Research – Bioprocesses for sustainability
Honorary Research Associate Dr Melinda Dunnett	Centre for Bioprocess Engineering Research – Process improvements and economics of large-scale production of spirulina and other micro-algae
Honorary Research Associate Dr Caryn Fenner	Centre for Bioprocess Engineering Research – Bioprocess development for vaccine production

NAME	RESEARCH FIELD

HONORARY RESEARCH ASSOCIATES

Honorary Research Associate Dr Rob van Hille	Centre for Bioprocess Engineering Research – Mineral biotechnology, algal biotechnology, microbial ecology, carbon cycling, sulphide chemistry and bioremediation, acid mine drainage retention treatment, anaerobic digestion and bioenergy
Honorary Research Associate Dr Sarah Jones	Centre for Bioprocess Engineering Research – Algal bioprocess systems and bioreactor design
Honorary Research Associate Dr Melissa Petersen	Catalysis Institute – Molecular Modelling
Honorary Research Associate Dr Madelyn Johnstone-Robertson	Bioprocess Engineering

ADJUNCT STAFF

Adjunct Professor Brian Joseph Chicksen	Minerals to Metals
Adjunct Professor Jeremy Mann	Centre for Minerals Research
Adjunct Professor Jens Thomas Muller	
Adjunct Professor Robert Pieter Schouwstra	Minerals to Metals
Adjunct Professor Michael Henry Solomon	Minerals to Metals
Adjunct Professor David William Wright	

RESEARCH **FOCAL AREAS & PROJECTS**

ALGAL BIOTECHNOLOGY
Microalgae have great potential for biomass and bioproduct production, 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, nutraceuticals, lipids, commodity and energy products in both ponds and closed photo bioreactors. The potential role of algae in CO^2 uptake and the potential of algae to bio-concentrate metals from wastewater is explored. We host a large algal culture collection, which is undergoing extended characterisation, and have developed approaches for its genetic improvement. Through the biorefinery concept, inventory analysis, and Life Cycle Assessment (LCA), we identify key contributions required for feasible algal processes, one of which is the design of low-energy reactor systems.

BIOTECHNOLOGY TOWARDS CHEMICALS, FOOD AND HEALTH PRODUCTS
South Africa has been an early adopter of a national bioeconomy strategy to integrate bioconversion and bio-based products into our economy, with the aim of diversifying from fossil-based resources towards an enhanced focus on sustainable and low-carbon processes. Research in fine chemicals and commodity bioproducts in CeBER focuses on combining process kinetics, metabolic modelling, product optimisation, induction and process sustainability. Commodity bioproducts, such as biofuels and polymers, are produced from renewable resources, including platform biochemicals. Bioconversion of linear alkanes yields value-added products such as alcohols, carboxylic acids, hydroxy acids and dioic acids. Recombinant microbial systems are used to maximise productivity of affordable modern biopharmaceuticals, antimicrobials and nutraceuticals. Plant cell culture and novel approaches for the genetic modification of plant cells and micro-algae are under development.

MINERAL AND METAL BIOPROCESSING
In biohydrometallurgy, microbial biocatalysts ensure the provision of leach agents for solubilisation of metals from minerals, providing an alternative for the recovery of metals such as copper, zinc, nickel or gold (via bio-oxidation) from low-grade ore or niche concentrates. Research focuses on both microbial and fluid contacting sub-processes within heap bioleaching, chiefly heap hydrology, solution flow and contacting with the mineral phase, their impact on microscale physicochemical conditions and on development and location of microbial communities, microbial ecology, structure-function relationships within consortia, whole-ore growth studies, leaching reactions and impact of gangue materials. The same understanding is used to minimise or prevent acid rock drainage (ARD). The intensification of tank bioleaching and microbial ecology in these systems are studied. Valorisation of secondary resources, including mine waste and urban waste, forms a key component of our circular economy approach. This includes repurposing mine waste into fabricated soils.

VALUE FROM WASTE
We are committed to the circular economy approach which necessitates not only environmental remediation of waste, but recovery of valuable products leading towards a zero-waste industry and concomitant sustainability. To this end CeBER makes use of our in depth understanding of biohydrometallurgical processes for improved characterisation of acid rock drainage potential and for exploring the inherent possibilities for both valorisation and mitigation of toxic potential of mine wastes. This includes technology recovery of residual mineral value, production of value-added chemicals, production and repurposing of benign fractions, and production of fit-for-purpose water. We also use our biohydrometallurgical expertise in seeking non-toxic options for recovery of metals from electronic wastes. Further, using the biorefinery principal, we use our understanding of a broad range of bioprocess systems and technologies for investigating the reuse of industrial and domestic wastes for simultaneous production of high-value products, commodity products, repurposed fractions, and fit-for-purpose water.

WATER AND THE ENVIRONMENT
Our research focuses on water treatment for the delivery of compliant, fit for purpose and, where required, potable water from domestic and industrial wastewater streams with embedded recovery of values using a circular economy approach. We seek to address water scarcity, a key driver in South Africa, in collaboration with the interdisciplinary research institute, Future Water. CeBER hosts complementary research projects treating process and domestic wastewater rich in organics, nitrogen and phosphate compounds, typical of the wastewater arena, with associated value recovery. Integrated systems, microbial ecology and the potential for value recovery are explored through the concept of a waste (water) biorefinery, using an industrial ecology approach, sustainability and life cycle analyses, and integrating emerging technologies for renewable energy. ARD and neutral mine-drainage prevention are addressed through the enhanced management of waste materials (see Mineral Bioprocessing) in collaboration with the Minerals to Metals signature theme. A key component is the development and refinement of the tools used for characterisation and prediction of ARD generation. ARD remediation using integrated biological technologies places particular emphasis on biological sulphate reduction, and partial sulphide oxidation to recover elemental sulphur.

PROFESSOR
JACK FLETCHER

CATALYSIS **INSTITUTE (CAT)**

THE CATALYSIS INSTITUTE COMPRISES THREE CENTRES, NAMELY THE CENTRE FOR CATALYSIS RESEARCH, THE DST-NRF CENTRE OF EXCELLENCE IN CATALYSIS AND THE NATIONAL HYDROGEN CATALYSIS COMPETENCE CENTRE (HySA/Catalysis).

The Catalysis Institute comprises arguably the leading heterogeneous catalysis research grouping in its field in South Africa and enjoys excellent relations with similar academic groups in Europe, North America and Asia as well as substantial co-operation with domestic and international industry. The Institute is comprised of three research and technology development centres, viz. the Centre for Catalysis Research (CatCentre), the DST – NRF Centre of Excellence in Catalysis (c*change) and the National Hydrogen Catalysis Competence Centre (HySA/ Catalysis). Whereas the CatCentre is wholly associated with catalysis activities at UCT and is largely focused on industrial catalysis, c*change and HySA/Catalysis are national centres with mandates in basic catalytic science and engineering, and technology development in the field of hydrogen and fuel cells, respectively. In keeping with its mission of commercially relevant research and technology development, three companies have been spun-out of the Institute, viz. HyPlat (Pty) Ltd, Cape Catalytix (Pty) Ltd and Hydrogen Energy Applications (Pty) Ltd – in the fields of fuel cell technologies, laboratory test equipment and hydrogen-fueled power generators, respectively.

CENTRE FOR CATALYSIS RESEARCH
Research in the Centre for Catalysis Research covers catalyst synthesis and modification, physico-chemical characterisation, molecular modelling of catalytic reactions and testing under industrially relevant conditions. Special focus is given to catalytic processes using feedstock and materials of particular interest to South Africa, although substantial industrial contract work, in association with predominately international partners, is undertaken through the Centre.

PROFESSOR
DAVID DEGLON

CENTRE FOR **MINERALS RESEARCH (CMR)**

ABOUT
The Centre for Minerals Research (CMR) at the University of Cape Town is a multi-disciplinary, inter-departmental Research Centre based in the Department of Chemical Engineering, with close collaboration with groups in the Department of Physics, Mechanical Engineering and the Centre for Research into Computational and Applied Mechanics. The Centre originated as a research group in 1980 and became formally recognized as a Research Unit in the 1990s. In 2006 the Unit was accredited by the University as a Research Centre. In 2012 and 2017 this accreditation was re-instated.

BACKGROUND
The Centre began as a small research group in the early 1980s and focused mainly on the chemistry of the flotation process. With time, the research expanded to areas such as the role of reagent interactions, the effect of the froth phase and investigation of novel flotation cells. In the early 1990s, a strong activity in the area of comminution began. A key development during the 1990s was the Centre entering into a highly successful joint research venture with the Julius Kruttschnitt Mineral Research Centre at the University of Queensland as part of the AMIRA P9 project. The P9 project is the world's largest and longest running university-based mineral processing research project and led to a period of rapid growth for the Centre. In the mid-2000s research in the Centre was significantly strengthened by the development of a strong process mineralogy activity. In 2006, the University recognised the research group as a Centre, which is now known as the Centre for Minerals Research (CMR). The Centre has a complement of 30 staff, 35-45 postgraduate students, has extensive support from leading mining companies, an international reputation for its research and strong links with research institutions globally.

PURPOSE
The Centre for Minerals Research conducts research in the areas of comminution, classification, froth flotation and process mineralogy. 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. Comminution research includes conventional crushers, high pressure grinding rolls, tumbling mills, roller mills, stirred mills and circuit modelling. Classification research includes cyclones, dry and wet screens. Flotation research includes flotation chemistry, flotation cells, flotation froths and circuit simulation. Process mineralogy research includes mineralogical textural descriptors and alteration processes. Approximately 40% of research is conducted within laboratories, 40% on either pilot or industrial plants and 20% by computational methods. The overall purpose of this research is:

"The development of multicomponent models, methodologies and heuristics for the design, integrated simulation and optimization of mineral processing concentrators".

Design, simulation and optimization involves developing a flowsheet within simulation software, populating this with relevant multicomponent process models, model fitting and calibrating the simulation to experimental survey data and using this to design or optimize process performance. The focus of the Centre is almost exclusively on concentrators employing the separation process of froth flotation, but may include other separation methods. Research is conducted within the battery limits of ore from the pit/mine until production of final concentrate, but includes research within geometallurgy. The research activities of the Centre are supported by a strong technology transfer group (MPTech) responsible for translating research outcomes into process improvement.

PROFESSOR
SUE HARRISON

CENTRE FOR BIOPROCESS **ENGINEERING RESEARCH (CeBER)**

Bioprocess engineering is a core discipline in bringing into being bio-based and nature-mimicking approaches to provide critical products. These include materials, fuels, metal-based products, commodities, food & feed and health products. Bioprocess engineering is orientated towards enhancing resource efficiency, maximising value creation from waste thereby minimising dissipated waste. It seeks to contribute to environmental, social and economic sustainability.

The vision of UCT's Centre for Bioprocess Engineering Research (CeBER) is to be an interdisciplinary research enterprise developing the nation's bioprocess engineers, providing innovation and new insights into bioprocesses and bioproducts and becoming a global leader in selected research niches. CeBER provides an environment in which to advance knowledge of bioprocess engineering, striving to be relevant and excellent and fuelling South Africa's developing bioeconomy. CeBER seeks to contribute to South Africa's resource industry through both fundamental and applied research built on an interdisciplinary approach. The Centre equips scientists and engineers at postgraduate level with expertise to excel in every sector of the bioprocess arena, from research and industry to environmental services and solutions. It maintains a diversity of disciplines across its teams of researchers and collaborators to nurture an interdisciplinary and enriched approach to research. CeBER builds on a foundation of bioprocess engineering research activity at the university started in the late 1960s and has been a UCT-accredited research grouping since 2001.

CeBER is home to eight academic staff members, four to eight postdoctoral fellows at any given time, six support staff, and some 60 postgraduate students. We aim to develop our students' expertise in bioprocess engineering and biotechnology principles and practice, and to engage in inter- and transdisciplinary research programmes, which provide fundamental knowledge and develop technologies to create social and economic benefit through sustainable bioprocesses and bioproducts for industry, the environment and society.

CeBER is recognised for its strong interdisciplinary focus, integrating biological understanding and process-engineering systems. Its particular strengths are in bioreactor design; biokinetics; 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 fine chemical and health products. CeBER's research contributes to the circular economy and resource efficiency while driving environmentally sustainable processes and socially responsive solutions in its transfer and application. We work together with the Minerals to Metals and Future Water IDTD research groupings.

PROFESSOR
ALISON LEWIS

CRYSTALLISATION & PRECIPITATION **RESEARCH UNIT (CPU)**

CRYSTALLISATION & PRECIPITATION RESEARCH UNIT (CPU)
PROFESSOR ALISON LEWIS

WHO ARE WE?
We are a group of curious and dynamic 'pattern sniffers'. We are passionate about the planet, sincere about sustainability and committed to research into crystallisation and precipitation.

RESEARCH FOCUS
Our focus is on precipitation and crystallisation research, mainly connected to hydrometallurgy, including Rare Earth Element recovery, PGM and Base Metal recovery and scaling salts. We also have a major interest in using crystallization and precipitation for water recovery and treatment. Specific projects involve treatment of desalination brines and precious-metal precipitation.

We have two main flagship projects: (i) the exciting and novel Eutectic Freeze Crystallisation Project, carried out in collaboration with Universities of Toronto, Lappeenranta and Aalto, Swedish Royal Institute of Technology (KTH), Norwegian University of Science and Technology (NTNU), University of Sao Paolo and Curtin University and (ii) our Rare Earth Element recovery project, carried out in collaboration with the Swedish Royal Institute of Technology (KTH),

SOME CURRENT RESEARCH PROJECTS

Consistent production of both ice and salt in EFC, MSc
Seeding to prevent gypsum scaling in EFC, MSc Novel crystallizer designs for EFC, MSc REE recovery from synthetic NiMH battery sulfuric acid leach liquors: testing seeds, MSc REE recovery from synthetic NiMH battery sulfuric acid leach liquors: testing mixing, MSc Systematic comparison of the effectiveness of water treatment processes, PhD Scale-up of the reactive precipitation of Nickel Hydroxide to industrial application, PhD Antisolvent precipitation of rare earth elements from waste streams using a fluidised bed reactor, PhD Process Design for recovery of rare earth elements.

INTERNATIONAL COLLABORATION
- Tianjin University, China
- Swiss Federal Institute of Technology (EPFL), Switzerland
- Technical University of Delft, Netherlands
- Norwegian University of Science and Technology, Norway
- Aalto University, Finland
- Lappeenranta University of Technology, Finland
- University of Toronto, Canada
- University of Sao Paulo, Brazil
- KTH Royal Institute of Technology, Sweden

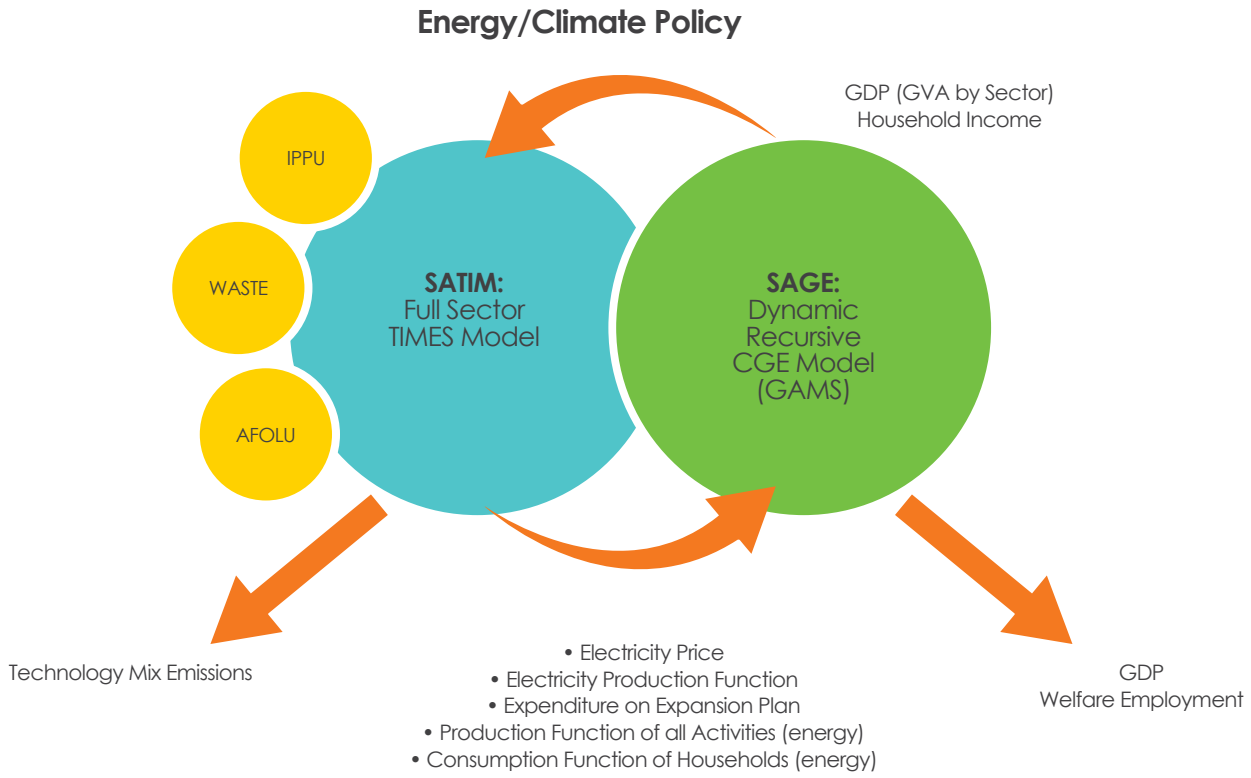
ENERGY & INDUSTRIAL **SYSTEMS ANALYSIS**

ESRG HARD AT WORK DURING LOCKDOWN TO UNDERSTAND SOUTH AFRICA'S GHG EMISSION FUTURES

Shortly before the Covid-19 lockdown starting in mid-March, the Energy Systems Research Group was approached to assist the Department of Environment, Fisheries and Forestry with the technical analysis for updating South Africa's nationally determined contribution (NDC) to climate change mitigation under the Paris Accord. The technical analysis was concluded by November and included several components. First, an assessment of what South Africa's "fair share" of the remaining global emissions budget is over the next decade. Second, our legal obligations in terms of greenhouse emissions reduction under the Paris Agreement. And finally the biggest part of the project: energy-economy-environment modelling of emissions scenarios for South Africa, with and without the implementation of current policies and plans to reduce greenhouse gas emissions, and with different economic growth rates. The modelling was undertaken using the South African TIMES linked General Equilibrium model (SATIMGE) modelling framework, which integrates a technology-based energy/emissions model (SATIM), and an economic model (ESAGE) built and maintained by the ESRG. The modelling framework was further enhanced by the addition of waste and land and agriculture models, so that the whole economy, and all greenhouse gas emission sources, are covered. The modelling framework can therefore evaluate not only policy interventions to reduce emissions or address energy policy problems, but also report on their social-economic outcome and other indicators vital to policymakers.

LIFE CYCLE MANAGEMENT OF PLASTICS – PHD AWARDED

The matter of environmental plastic pollution has been getting much attention in recent years, not just from civil society but also from commerce and industry. In keeping with its skills base in life cycle assessment, E & ISA have been working to generate insights to address this problem better. This endeavor reached a highlight with the award of a PhD to Takunda Chitaka in December 2020, for her work to develop a leakage indicator to help life cycle managers prioritize products for interventions. In her research, Takunda combined quantitative methods (LCA and statistics to describe debris collected in beach accumulation surveys) with qualitative methods (interviews with managers and stakeholders). The line of work is continuing through another PhD, started in 2020, studying how a circular plastics economy in South Africa could be achieved.



Schematic of the SATIMGE2020 Model

DR KIRSTY CARDEN
Civil Engineering,
Interim Director

FUTURE WATER: UCT'S **WATER RESEARCH INSTITUTE**

The Future Water research institute is hosted by the Faculty of Engineering and the Built Environment, and was founded in 2016 in response to UCT's call for the development of critical inter- and transdisciplinary research initiatives.

Following Prof Sue Harrison's move to DVC:Research & Internationalisation in August 2019, the institute is now led by Dr Kirsty Carden (Civil Engineering, interim director) and Professor Neil Armitage (Civil Engineering, deputy director). The core research team brings together academics from all six of UCT's faculties, and 10 Departments, including Chemical Engineering, Civil Engineering, African Studies, Construction Economics and Management, Architecture Planning and Geomatics, Environmental and Geographical Sciences, Public Law, Social Anthropology, and Public Health.

We focus on addressing water scarcity and developing water-sensitive approaches that sustain society's current and future water needs. Future Water is driven by the urgent need to enhance capacity for managing water scarcity and building resilience; to innovate so that water supply meets demand; and to ensure technically sound, socially acceptable and sustainable water management policies and practices. We aim to increase knowledge and understanding of water issues, improve water management and water governance, and increase capacity across the water sector.

To achieve this, we seek to integrate technical and socio-economic aspects of water through inter- and transdisciplinary scholarship as well as multi-stakeholder and user perspectives. Using this approach, we plan to consolidate existing research strengths and resources as a platform from which to launch new directions in water research towards sustainable and resilient futures.

FUTURE WATER RESEARCHERS IN CHEMICAL ENGINEERING

CeBER – Sue Harrison, Thanos Kotsiopoulos, Juarez Amaral-Filho, Mariette Smart

CMR – Kirsten Corrin

CPU – Alison Lewis

EPSE – Harro von Blottnitz, Fadiel Ahjum

MtM – Jenny Broadhurst, Michael Solomon, Megan Cole

FUTURE WATER RESEARCH THEMES

WATER SENSITIVE DESIGN

Promoting water efficiency, reuse and recycling, as well as the (re) design of settlements to include blue-green infrastructure, sustainable drainage systems, alternative water resources and water conservation strategies.

INTEGRATED WATER RESOURCE MANAGEMENT

Investigating the diversification, efficiency, recovery and reuse of water as well as linkages and dependencies between sectors in the water-energy-food nexus. We also promote innovation, and designing cost-effective water monitoring systems by working with multiple partners.

RESOURCE RECOVERY FOR THE CIRCULAR ECONOMY

Shifting from widely-prevalent linear water management models, to more circular approaches that encompass resource recovery and value from diverse forms of waste, including urine.

ADDRESSING DIVERSE RELATIONS AND VALUES AROUND WATER

Through all of our research we strive to understand the variety of ways that people interact with and value water. We also explore people's attitudes and behaviours in relation to water, making use of arts-based approaches, participant observation to develop ethnographic explorations, and other innovative methods.

MINERALS **TO METALS** (MTM)

Minerals to Metals (MtM) was established in May 2007 as one of five University of Cape Town Signature Research projects, with the aim of integrating, enhancing and expanding capacity to facilitate sustainable exploitation, development and utilization of mineral resources within Africa and beyond. The vision of Minerals to Metals is to play a leading role in the global mineral's sector by conducting inter- and multi-disciplinary research, developing capacity of future leaders within the minerals sector, as well as bridging the gap between academia and industry via partnerships and collaboration. The continuously evolving portfolio of research projects comprises projects in the thematic areas of mineral value chains and strategic minerals; license to operate (social and legislative); value from waste (repurposing mine waste and urban mining); post-mining transformation; artisanal mining; and development of decision-support tools and approaches. These research foci are strongly underpinned by the fundamental principles of science and engineering, whilst intersecting with the impacts of the sector on the broader environment and society.

Leadership is provided by Prof Jochen Petersen (Director)and A/Prof Jennifer Broadhurst (Deputy Director), assisted by EXCO members Prof Sue Harrison, A/Prof Megan Becker, Prof Harro von Blottnitz, Prof David Deglon and Prof Aubrey Mainza. Work under MtM is supported by researchers Dr Thandazile Moyo, Dr Cledwyn Mangunda and Dr Megan Cole, as well as Adjunct Professors Michael Solomon, Caroline Digby and Brian Chicksen. In line with the interdisciplinary ethos of MtM, many of the projects involve collaboration with researchers and academics across other disciplines and groupings, both within and beyond UCT. One example is the NRF Community of Practice project on Resilient Futures which brings together four SARChI Chairs (Bioprocessing, Mineral Law, Minerals Beneficiation and Development Economics) to investigate whether fibre-rich biomass (bamboo, hemp and kenaf) can be used to simultaneously remediate degraded land and provide opportunity for economic growth beyond the life-of-mine. A further NRF Community of Practice 'Waste to Value' was launched in 2020 to focus on developing strategies towards creating a circular economy in the context of the South African waste recycling industry, with Urban Mining being a key theme hosted in MtM. Work under this theme focuses on collection, dismantling and processing of e-waste as well as the legal and socio-economic frameworks that guide these activities.

MtM is also host of the Global Challenges Research Fund Mine Dust & Health Network which provides an inter-disciplinary and multi-sectoral platform which aims to develop a shared and common understanding of the inter-related health risks relating to mine dust, and to identify priority research areas and activities to address these.

In terms of education and training, MtM aims to develop what has been termed 'T-shaped' professionals – those who have depth (the vertical dimension, from the analytical expertise developed through postgraduate research) as well as breadth (the horizontal dimension achieved through working alongside of, and interacting with, individuals from a wide range of disciplines and backgrounds). This is achieved through the development of interdisciplinary courses and academic programs, as well as the MtM Forum, a weekly-lunch-hour gathering of students, academics and external stakeholders to explore and debate often controversial topics around mining and society in transition. Particular achievements in 2020 were the hosting of the Leaders in Extractives for African Development (LEAD) program in conjunction with the Mining Indaba as well as the very successful launch of the online Forum in collaboration with SAIMM, drawing a weekly audience of 60-100 participants.

PROFESSOR
JOCHEN PETERSEN

HYDROMETALLURGY **(HYDROMET)**

THE HYDROMETALLURGY RESEARCH GROUP (HYDROMET) FORMED IN 2016 UNDER PROF JOCHEN PETERSEN'S LEADERSHIP. IT HAS NOW GROWN INTO AN INTERNATIONALLY WELL-RECOGNISED RESEARCH GROUPING, ESPECIALLY THROUGH COLLABORATIONS UNDER THE MINERALS TO METALS INITIATIVE.

Hydrometallurgy is at the core of many extractive metallurgical processes, material synthesis as well as electrochemical processes and energy storage. It is finding renewed interest due to its perceived 'greener' processing of minerals in aqueous solution at moderate temperatures with manageable emissions. In particular, heap leaching is a technology in which coarsely crushed ores are treated directly by aqueous solutions in large stockpiles at the mine-site, obviating the need for energy intensive fine grinding of ore and serious water losses through the storage of tailings material. *In situ* leaching takes this a step further in that the ore does not even need to be mined. Extractive hydrometallurgy further enables the simultaneous recovery of minor elements (those of value and those considered toxic) which is of particular interest in the mining of polymetallic mineral ores and waste materials in the context of sustainability.

Research under Hydromet focusses on a number of topics, both fundamental and applied: investigation of alternative chemistries for the recovery of PGMs and gold (thiocyanate, ferricyanide, iodine) and for the leaching of the refractory copper mineral chalcopyrite (sulphate, ammonia and chloride systems and the role of organic additives). Studies using electrochemical methods have gained particular traction, and the group has built up some expertise in this regard through the support of Hon. Prof Mike Nicol who regularly visits at UCT, also in 2020. Research in the area of heap leaching, where Prof Petersen enjoys considerable international recognition, focusses on gas and solution flow through heap beds as well as the study of solute migration through the cracks and pores of large particles. Other research topics include ion exchange, extraction of rare earth metals and metals recovery from e-waste. Hydromet collaborates widely within the Department and internationally. Key collaboration under the Urban and Artisanal Mining and Strategic Minerals themes occur in the Minerals to Metals Initiative which Prof Petersen heads as the SARChI Chair for Mineral Beneficiation.

Several projects in the area of metal extraction from e-waste received significant funding from both national and international agencies. In particular, Prof Petersen was awarded the German African Innovation Incentive Award (GAIIA) for the project 'Value Recovery from e-Waste in Africa (VaReeWA)' in collaboration with RWTH University Aachen. He also chairs the NRF Community of Practice 'Waste to Value' which brings together 5 SARChI Chairs in waste management and value extraction. Among other, this funding has allowed the recruitment of Dr Thandazile Moyo as a Research Officer to the Hydromet team.

The Hydromet group has graduated 1 PhD and 5 MSc in 2020 and published 7 articles in peer reviewed journals. Prof Petersen presented online at 3 international conferences.

Professor Petersen held the following Honorary Appointments last year: Visiting Professor: Wuhan Institute of Technology (2019-2022); Central South University, Changsha (2018 onwards); Kunming University of Technology, China (2017 onwards); Editor-in-Chief, Hydrometallurgy, Elsevier (2013-present).

The Publications

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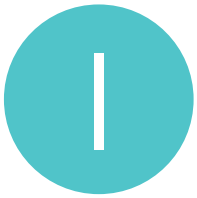

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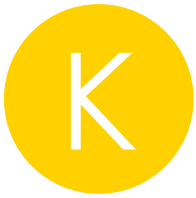

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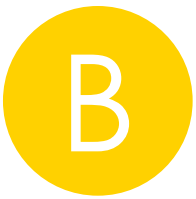

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