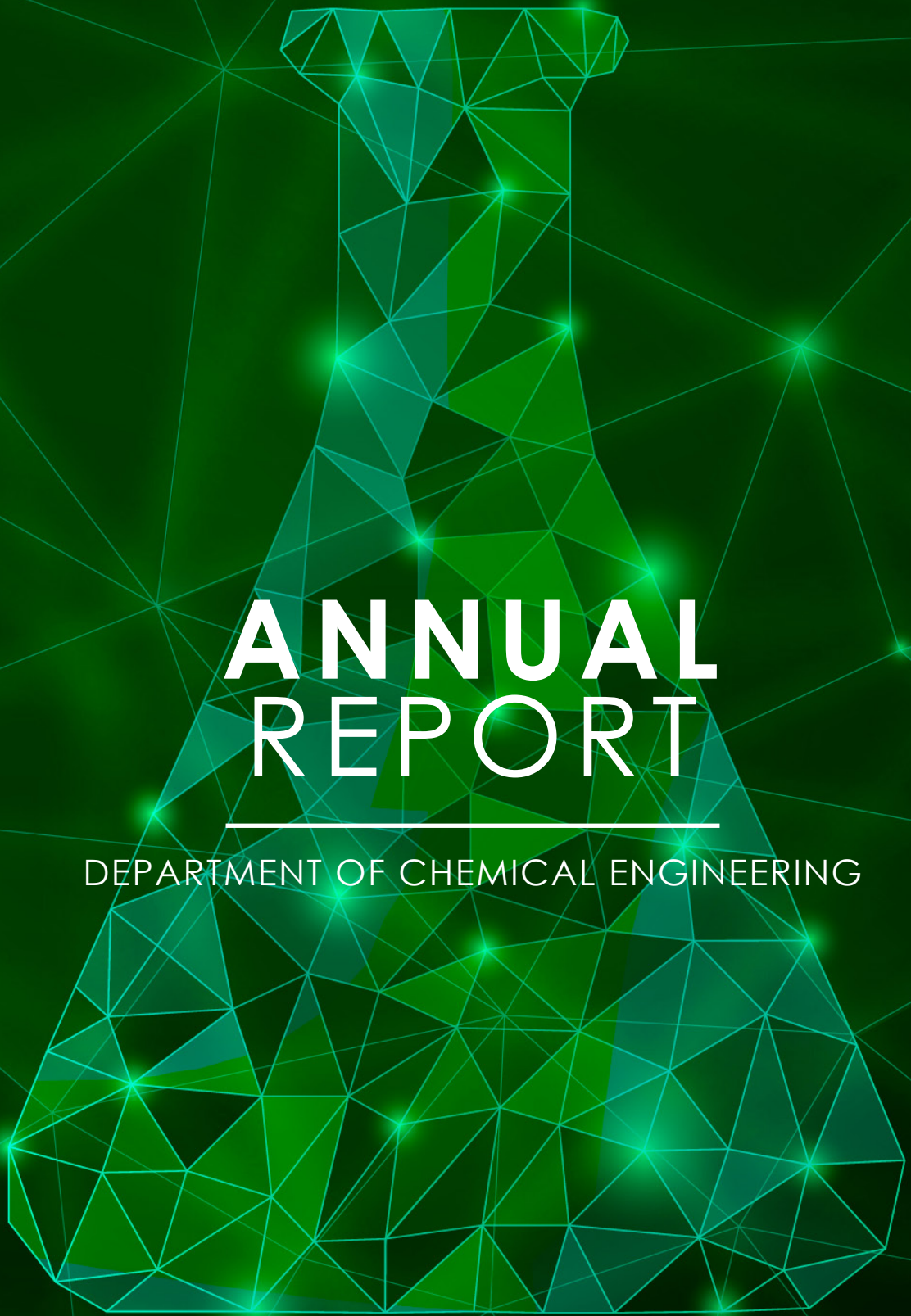
2023

ANNUAL REPORT

DEPARTMENT OF CHEMICAL ENGINEERING



UNIVERSITY OF CAPE TOWN

IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

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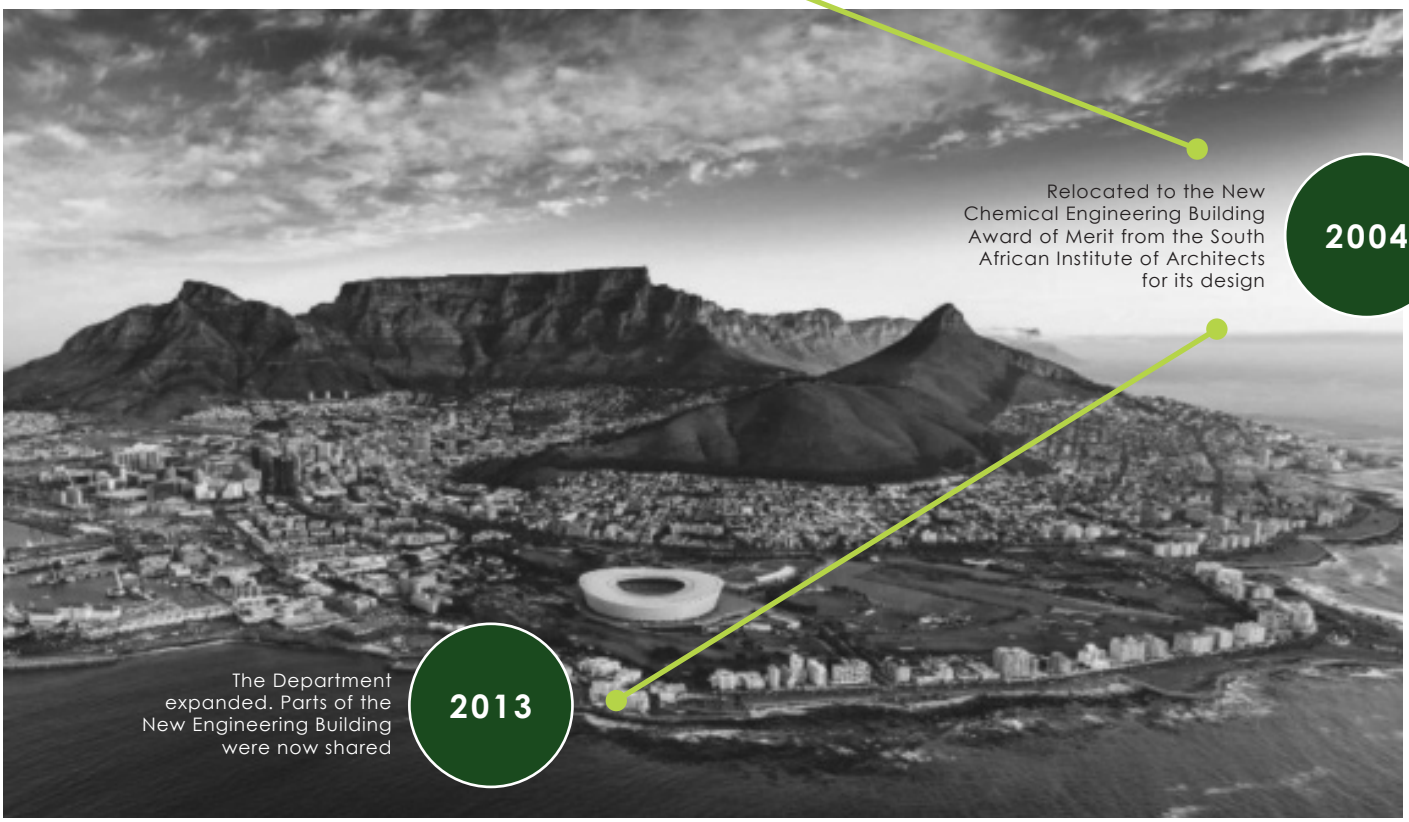


OUR HISTORY

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 5%, 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.

OUR VISION 2024

01 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.

02 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.

03 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.

PROFESSOR ADENIYI ISAFIADE
HEAD OF DEPARTMENT

FOREWORD

FOREWORD

In 2023, we had the opportunity to build on the progress made in research, teaching, and learning activities as we returned to normal operations following the challenges of the COVID-19 pandemic.

Since reverting to face-to-face teaching and learning for all undergraduate and postgraduate courses and research activities, the department has built on lessons learnt from the COVID-19 pandemic to improve course delivery and research outputs. The pandemic also provided an opportunity to rethink daily operations while fulfilling our mandate to students, industry, and society. In response to the pandemic's impact, the department implemented measures to ensure the graduating class of 2023 met the high standards we had set.

Although the year began with protests, the materials developed for remote teaching and blended learning during the COVID-19 pandemic were utilised to ensure no time was lost. In the 2023 academic year, 72 students graduated with a Bachelor of Science in Chemical Engineering, 28 with a Master of Science, and 9 with a Doctor of Philosophy. Despite power supply challenges in South Africa, the department adopted alternative energy sources to minimise disruptions.

The department continues to improve its undergraduate and postgraduate programs to address current global challenges, particularly those related to the climate change crisis and opportunities provided by the Fourth Industrial Revolution. Key highlights in the 2023 academic year include the full rollout of an engineering specialisation course on renewable energy in the final year curriculum, and a data science module in the third-year curriculum. The renewable energy course, well received by students, had a good pass rate and is being further developed into a dedicated textbook. The data science module, successfully implemented in collaboration with Professor Lidia Auret from Stone Three, has prompted a revamp of our computing strand to support the module and prepare graduates for the rapidly evolving era of artificial intelligence. The department is grateful for the financial support provided by the Minerals Education Trust Fund.

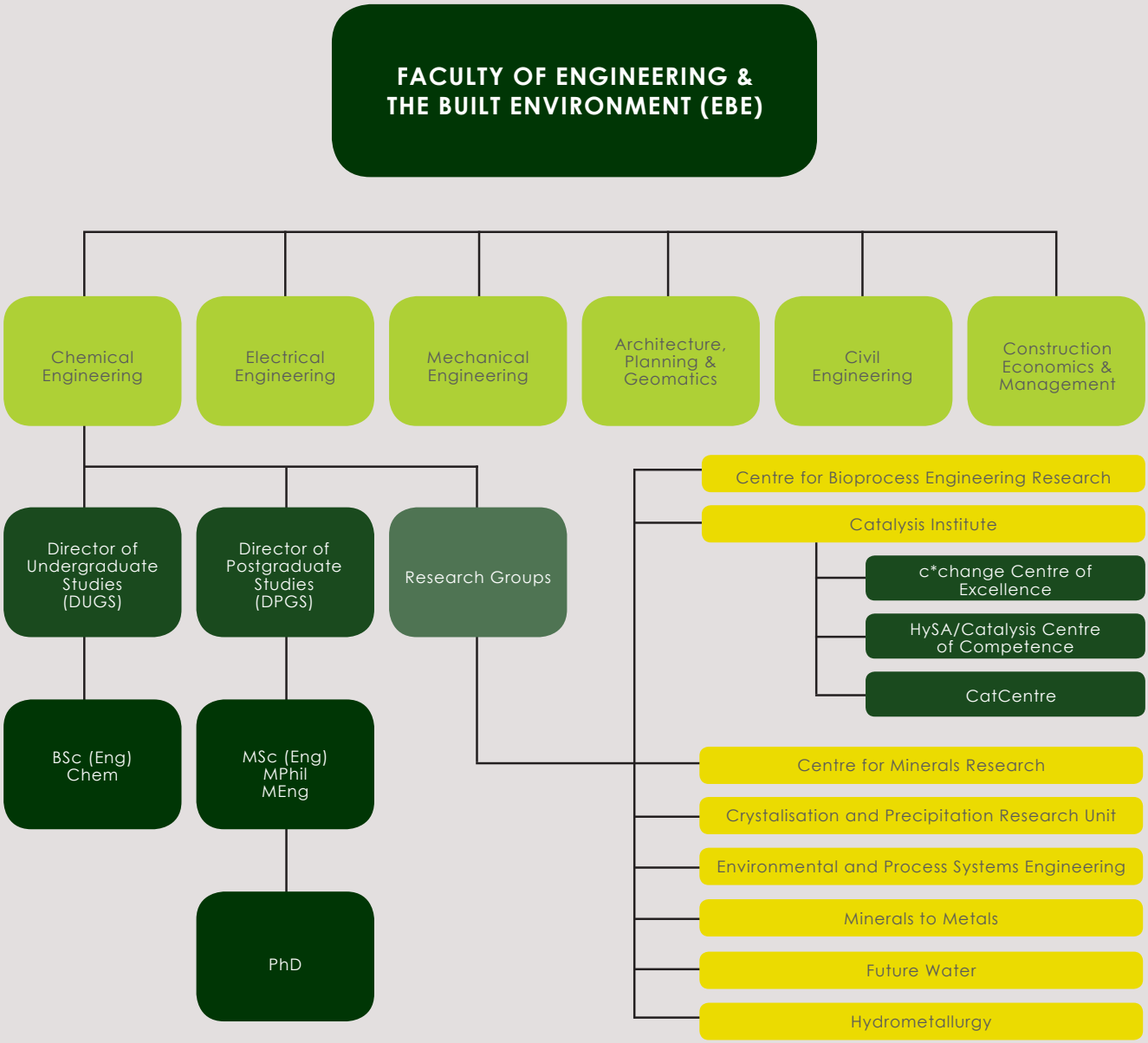
In the research space, experiments for postgraduate studies and industrial contracts that resumed after returning to normal operations, continued unhindered. This led to many students graduating with Masters and PhD degrees, and contract deliverables were achieved. In 2023, the department also opened a data science and visualisation center, equipped with technology to aid in the generation, processing, and visualisation of data in various formats. The department is grateful for the support provided by Stone Three in the design and operation of the center.

We look forward to 2024, and hope it will be a year of prosperity.

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; 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 masters and doctoral degrees. The Department has recently restructured its undergraduate BSc (Eng) degree, with a strong focus on integrated project work and 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.


FACULTY OF ENGINEERING & THE BUILT ENVIRONMENT (EBE)
Chemical Engineering
Electrical Engineering
Mechanical Engineering
Architecture, Planning & Geomatics
Civil Engineering
Construction Economics & Management
Director of Undergraduate Studies (DUGS)
Director of Postgraduate Studies (DPGS)
Research Groups
BSc (Eng) Chem
MSc (Eng) MPhil MEng
PhD
Centre for Bioprocess Engineering Research
Catalysis Institute
c*change Centre of Excellence
HySA/Catalysis Centre of Competence
CatCentre
Centre for Minerals Research
Crystalisation and Precipitation Research Unit
Environmental and Process Systems Engineering
Minerals to Metals
Future Water
Hydrometallurgy

FACILITIES & EQUIPMENT

The department runs an analytical laboratory, an electronic workshop, a mechanical workshop, and an experiential learning facility.

ANALYTICAL LABORATORY
The Analytical Lab has a dedicated, experienced team that provides analytical and material characterisation services to the Department of Chemical Engineering and other departments at UCT. The services are extended to other Universities, private companies, and small-medium enterprises. The laboratory is equipped with a microwave digestion unit for the acid digestion of solid samples, together with an MP-AES and Agilent ICP-OES for total metal analysis. Students and researchers also have access to particle size analysis and zeta potential measurements using a Malvern Mastersizer 3000 and Zetasizer, respectively. Physisorption, chemisorption and other temperature-programmed sorption experiments can be performed on a Tristar, ASAPs and AutoChems. In addition to the scientific support provided on instruments in the Lab, the Analytical Lab Team is responsible for co-ordinating waste disposal for all the research groups in the department.

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 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 of 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 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. 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, 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).

SAFETY & RISK MANAGEMENT

The Department of Chemical Engineering is cognisant of the many occupational health, safety and environment (OHSE) 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 instill a 'no harm' ethos in both our teaching and research operations.

OHSE IN LABORATORIES AND THE WORKPLACE
The department has a formal safety structure lead by the HOD and the departmental safety officer. Each of the major laboratory-based research groups and workshops has a further safety officer and safety representatives supporting their work in the day-to-day monitoring and implementation of safety issues. The team is complemented by evacuation marshals, first aiders and a chief fire officer. We hold quarterly meetings in which laboratory inspections and incidents are reported and discussed.

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
In 2022, the department started a project to revitalise the annual SHE induction. Through a professional filming crew and with the support of staff and student volunteers, a high quality fifteen minute SHE induction video was produced. This resource will enable the department to conduct full safety inductions throughout the year for new staff and students as well as short-term visitors.

'NO HARM' ETHOS
Our vision is to be Africa's leading chemical engineering department, through teaching and research. Safe and healthy learning 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

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

THE PROGRAMMES

UNDERGRADUATE PROGRAMME

In the UCT Chemical Engineering 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 Sciences and Humanities. The degree design is unique in Africa and is informed by cutting-edge international developments in engineering education. Our teaching centres focus on a philosophy of hands-on learning and the development of technical expertise, problem-solving, teamwork and communication skills. Students can also customise their degrees to focus on minerals processing, bioprocess engineering, catalytic processing, process modelling, or environmental process engineering. The undergraduate programme works closely with industry and with industrial partners providing many vital inputs. These include: bursaries for students; placements for student field-trips and work experience (which all students must complete to be awarded the degree); guest lecturing to students; service on the Advisory Board; financial support from the Minerals Education Trust Fund; and significant contributions to new and improved equipment and infrastructure.

Two exciting changes were made to the UCT undergraduate Chemical Engineering programmes in 2023. The first change was the introduction of a new data science block in CHE3007S, which was retitled "Data Science, System Dynamics, and Process Control". This new theme was incorporated following consultation with alumni, industry and current students who identified data science as a key skill now needed by engineering graduates. The block was developed and delivered by Prof. Lidia Auret (from Stone Three) and Mrs Tracey van Heerden, in collaboration with Prof. Niyi Isafiade and Dr Kyle Abrahams. Secondly, a new 4th year chemical engineering elective course was offered, entitled "Renewable Energy in the Process Industry" and convened by Prof. Eric van Steen. The course proved to be incredibly popular, with more than half of our final year class opting to take it.
In 2023, 127 new students from a diverse range of backgrounds entered the undergraduate programme (Figure 1). This number continues the return to the class sizes of 2017 and prior, after a dip having been recorded for 2018-2020. Of the new students, a quarter to a third typically voluntarily transfer into the five-year (ASPECT) programme after the first term, with the rest remaining in the four-year (Mainstream) programme. The students in both the four- and five-year programmes are supported through a variety of measures, including: a first-year mentorship scheme; a first-year team-building camp; dedicated year-advisors; a well-developed tutor system; an industrial field-trip in second-year; and intensive winter and summer boot camps for students experiencing difficulties during the normal semester in the first to third years of our programme.

These initiatives have enabled the department to produce an average of 90 graduates per annum over the past five years (Figure 2 and 3), with 72 students completing their undergraduate chemical engineering degree requirements this past year. The relatively small 2023 number of graduates was due to lower intake numbers over 2018-2020 (seen in Figure 1), as well as being a result of a decrease in throughput statistics, influenced by the COVID-19 pandemic. With respect to the latter, all of the graduating students completed most of their degree under the COVID-19 pandemic, and 2020 was the first year at university for the majority of the class. Despite this unprecedented challenge, 69% of the graduates in the Mainstream programme completed the degree in four years and 64% of graduates in the ASPECT programme completed the degree in five years. Furthermore, 18 students (25%) achieved First Class Honours and 23 (32%) were Honours students. Also of note is that 60% of the graduating class was female. This is only the third time in the department's history that there have been more female than male graduates, and it is the largest female percentage ever in a graduating class.

OVERALL INTAKE: 2013-2023

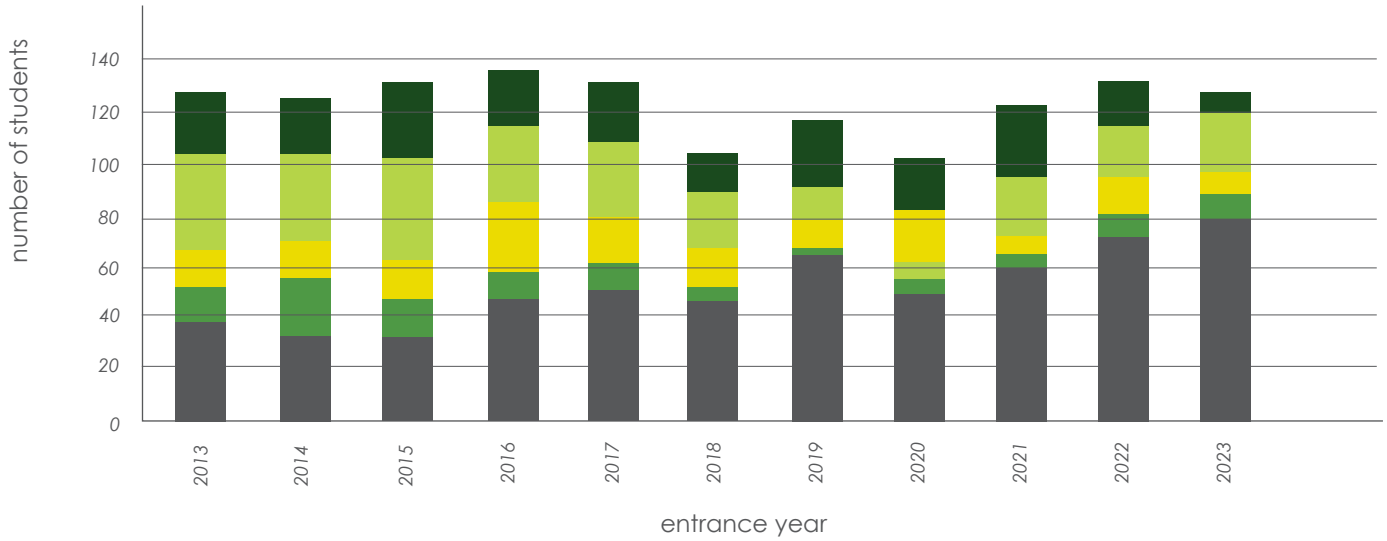


Fig 1: Overall intake between 2013 and 2023 by population group

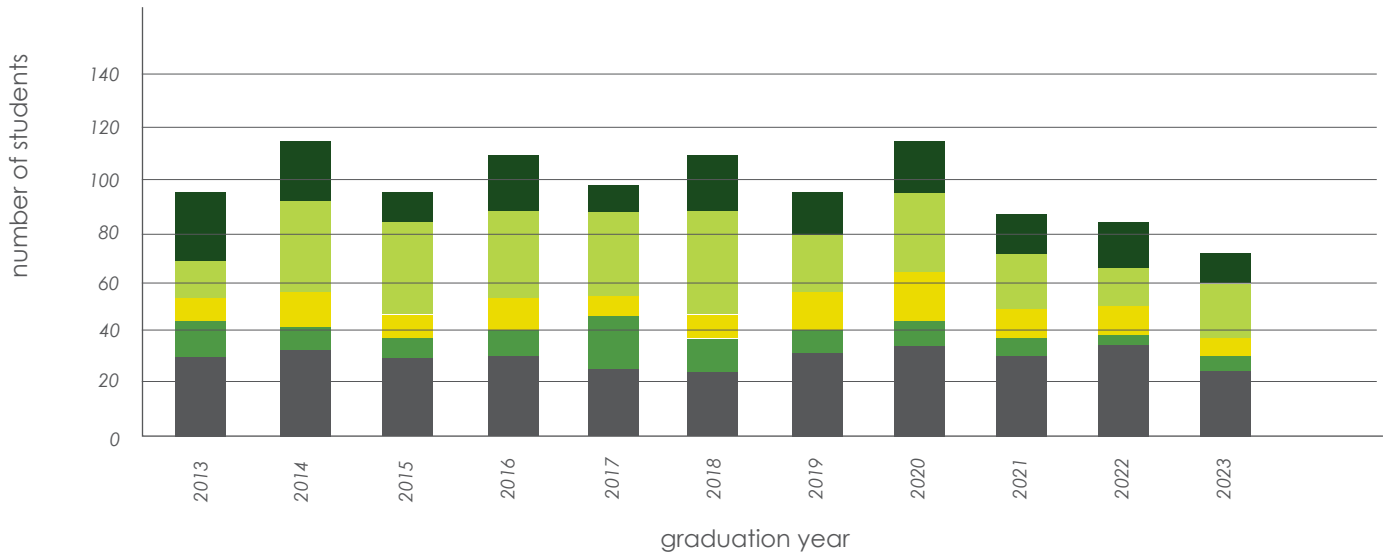


Fig 2: Number of graduates between 2013 and 2023 by population group

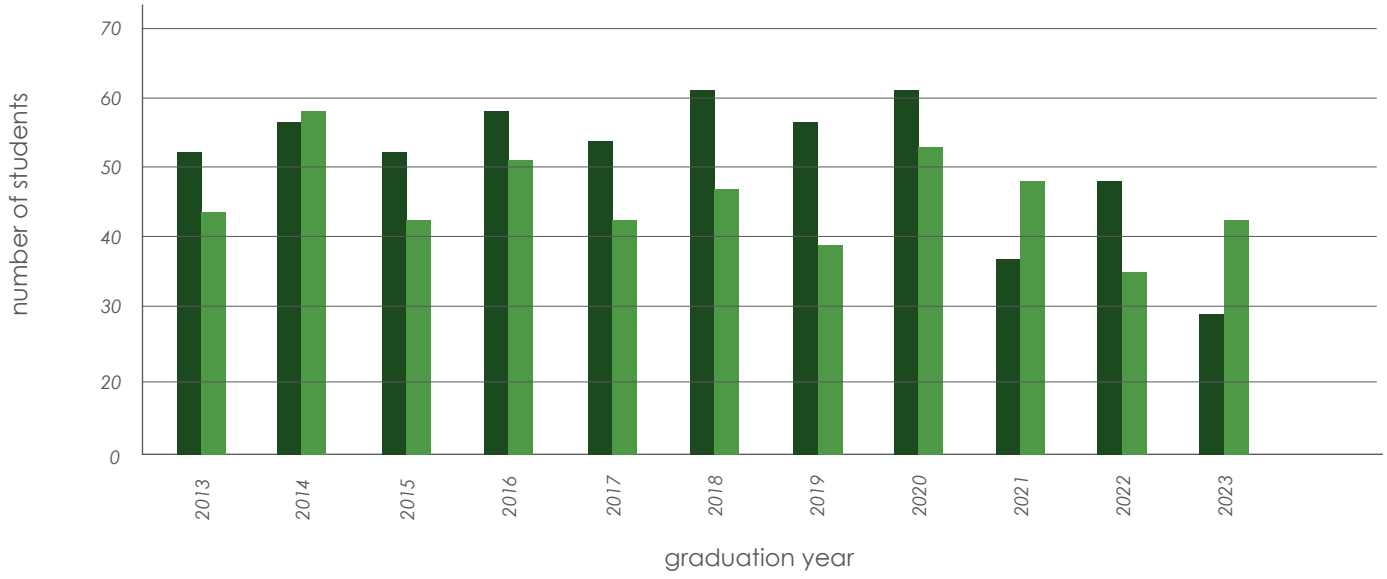


Fig 3: Number of graduates between 2013 and 2023 by gender

BSC CHEMICAL ENGINEERING
GRADUATES (72) IN 2023

Abiodun, Emmanuel Ifeoluwa	First Class Honours
Arendse, Zoë Louise	First Class Honours
Aspeling, Dedri	Honours
Baboolal, Nikash	Honours
Bernhardi, Michael Christian	First Class Honours
Calaz, Rachel Elizabeth	First Class Honours
Cele, Mongezi Ntethelelo	Honours
Chibaya, Theresa Vongai	
Creighton, Amiera	
Crowther, Emma	First Class Honours
De Vlieg, Luisa Ruth Pereira	First Class Honours
Ebrahim, Rana	First Class Honours
Elliott, Joshua Matthew	First Class Honours
Evanson, Zachary Conrad	
Fourie, Mitchell Marcel	
Gumede, Siphelele Lindokuhle	
Hassan, Noor Zara	First Class Honours
Holiday, Tevin President	
Hutton, Sarah Elizabeth	Honours
Israel, Tannah Jade	First Class Honours
Joubert, Francesca	First Class Honours
Kahanovitz, Benjamin Howard	First Class Honours
Khetsi, Relebohile	Honours
Koyo, Apelele	
Mabaso, Lungelo	Honours
Madziya, Tariro Priscilla	Honours
Malatji, Tshepang Mishelle	Honours
Maliboho, Nyengedzo Princess	Honours
Maliehe, Mamello	
Mashamba, Tafadzwa Joyful	First Class Honours
Maswinyaneng, Makokorope Sebodu	
Matlakale, Reneilwe Entle	
Melamane, Sokhanya	
Metsing, Thato Esther	
Mhlonyane, Zinathi	
Modjadji, Mashala	Honours
Mokoena, Khothatso David	
Mortimer, Grace Elizabeth Tess	First Class Honours
Motlekar, Zahra	
Moyo, Bokani Nkosilathi	Honours
Msimeki, George Hlonipho	
Msomi, Zizile Lisa	Honours
Murray, Nadia	First Class Honours
Musabayana, Rufaro David	Honours
Naidu, Ria Bela	Honours
Ndebele, Petros Tefo	
Ndlovukazi, Ntandoyenkosi Phiwayena	
Needhi, Sonali	
Neff, Thomas Rueben	Honours
Ngoveni, Kulani Gontse	Honours
Ngubane, Nomvelo Nonjabulo	
Ngxongo, Simanga Sizwe	Honours
Owen-Jones, Nina	First Class Honours
Padayachee, Taniel	Honours
Peyron, Lauren Morgan	First Class Honours
Polorigni, Tlhologelo Welheminah	
Punabantu, Nawa Uriel	Honours
Qosho, Anathi Na	
Ramabubuda, Mpho	Honours
Salie, Layan	
Sebastian, Rene	

BSC CHEMICAL ENGINEERING
GRADUATES (72) IN 2023

Sekudu, Queen Ntombizodwa	
Singh, Dhiajal Sundeep	Honours
Snyders, Verushka Nikita	
Solomons, Ryan	First Class Honours
Sooklall, Tousheeka	
Swart, Micka	Honours
Taverna-Turisan, Luca	Honours
Tshabalala, Nkosinathi	
Van Wyk, Cameron Justin	
Vidal-Hall, David Charles	Honours
Wessels, Chad Dante	

POSTGRADUATE PROGRAMME

Postgraduate programmes are a core component of the departments' offerings. Postgraduate students play a crucial role as teaching assistants in the undergraduate courses, and therefore the postgraduate programmes are essential to the functioning of the department as a whole.

The department offers a PhD and a research only MSc(Eng) (both by dissertation), a taught MSc(Eng) and a taught MPhil (both by coursework and partial dissertation) degrees. These degrees may be carried out in any of the following research areas: bioprocess and catalytic process engineering; crystallisation and precipitation; environment and process systems engineering; hydrometallurgy; minerals processing; polar engineering and process modelling. The MSc(Eng) by a combination of coursework and research, is offered in the areas of bioprocess and catalytic process engineering.

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 (CHE5055F/S), 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.

MASTERS CHEMICAL ENGINEERING
GRADUATES (28) IN 2023

Chikukwa, Deborah	MSc(Eng) by Dissertation (with distinction)
Chitranshi, Vidushi	MSc(Eng) by Dissertation (with distinction)
Duvenhage, Melanie	MSc(Eng) by Dissertation
Gani, Raeesah	MSc(Eng) by Dissertation (with distinction)
Gonte, Melissa	MSc(Eng) by Dissertation
Guni, Felix	MSc(Eng) by Dissertation
Khan, Saahil	MSc(Eng) by Dissertation (with distinction)
Magudu, Anam	MSc(Eng) by Dissertation (with distinction)
Mapeta, Malcolm	MSc(Eng) by Dissertation
Masuku, Wilson	MSc(Eng) by Dissertation
Matogo, Dennis	MSc(Eng) by Dissertation
Miiro, Eddy	MSc(Eng) by Dissertation
Ngau, Michael	MSc(Eng) by Dissertation (with distinction)
Nyaruwata, Everjoice	MSc(Eng) by Dissertation (with distinction)
Payne, Eric	MSc(Eng) by Dissertation (with distinction)
Peku, Zandile	MSc(Eng) by Dissertation
Ragoo, Yatheshtharao	MSc(Eng) by Dissertation
Sibanda, Jonathan	MSc(Eng) by Dissertation
Ssekimpi, Karen	MSc(Eng) by Dissertation
Strauss, Athena	MSc(Eng) by Dissertation (with distinction)
Tshinavhe, Tendo	MSc(Eng) by Dissertation (with distinction)
Van Coller, Cari	MSc(Eng) by Dissertation (with distinction)
Cotterrell, Stephen	MSc(Eng) by Partial Dissertation and Coursework
De Kock, Karina	MSc(Eng) by Partial Dissertation (with distinction) and Coursework
Ketlogetswe, Oitse	MSc(Eng) by Partial Dissertation (with distinction) and Coursework
Mawunge, Nyasha	MSc(Eng) by Partial Dissertation and Coursework
Munro, Tiaan	MSc(Eng) by Partial Dissertation (with distinction) and Coursework
Ntola, Siqhamo	MPhil (with distinction in dissertation)

PHD CHEMICAL ENGINEERING
GRADUATES (9) IN 2023

Beiza Lazcano, Luis Humberto Raul	PhD	Manenzhe, Resoketswe	PhD
Dzinza, Lucia	PhD	Mwale, Adolph	PhD
Kamanzi, Kankindi Conchita	PhD	Odidi, Michael Dumisane	PhD
Khoza, Thulile	PhD	Stander, Helene-Marie	PhD
Mahlaba, Sinqobile	PhD		

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THE RESEARCH

NEWS
NOTEWORTHY NEWS

UCT BREWING TEAM

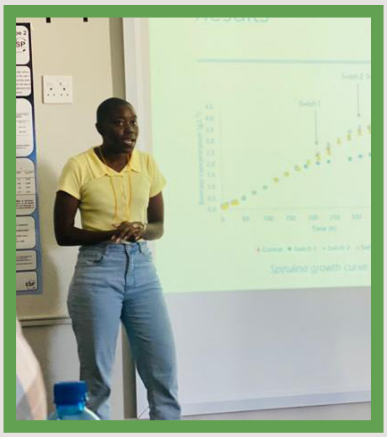
Congratulations to the UCT brewing team for winning the Best Beer in Show Award a record 6 times. The Team won the IPA category (with the American IPA) and with this beer they also won the Best Beer in Show Award. The team came 2nd in the African Wild Ale and Low Alcohol Summer Beer Categories and took 3rd for the Lager and the Label design. The Brewing Team continues to make UCT proud.

2023 FLOTATION CHEMISTRY GROUP WITHIN THE CMR:

- Kirsten Corin was invited to become an Associate Editor of Minerals Engineering.
- Kirsten Corin was invited to become an Associate Editor of Physicochemical Problems in Minerals Processing.
- Kirsten Corin was invited to present the JKMRC Friday Seminar at the Julius Kruttschnitt Mineral Research Centre, University of Queensland, Australia in July 2023.
- Cyril O'Connor was invited to present a Signature Lecture for the Australian Research Council's Centre of Excellence for Enabling Eco-efficient beneficiation of minerals (ARC CoE Minerals) in November 2023.
- Cyril O'Connor was invited to present a Plenary Lecture at the Balkan Minerals Processing Congress (BMPC 2023), Kosovo, 28-31 May 2023.
- Cyril O'Connor was invited to present a Plenary Lecture at the 10th International Symposium on Lead and Zinc processing, Changsha, China,17-20th October 2023.
- The Centre for Minerals Flotation Chemistry group was invited to present a series of seminars to the CSU post graduate students in Changsha in October 2023.

Professor Cyril O'Connor

Kirsten Corin



Congratulation to Karen Ssekimpi (who graduated with their MSc from CeBER last year), and William Middleton (a current MSc student in CeBER) won awards at the PSSA 2023 conference.

The 33rd Congress of Phycological Society of Southern Africa (PSSA) took place on the 23rd-27th of January 2023, in Arniston, Western Cape. The conference is attended by industry, researchers and students involved in the study and use of micro- and macroalgae. The program included a wide range of phycological topics, such as high value products, algal reactor design, aquaculture, climate change, ecology, genomics, harmful algal blooms, waste water treatment. CeBER was represented by a number of MSc students as well as Dr Nodumo Zulu. MSc student Karen Ssekimpi was awarded 2nd prize in the oral presentation category and William Middleton was awarded 1st prize in the poster category.

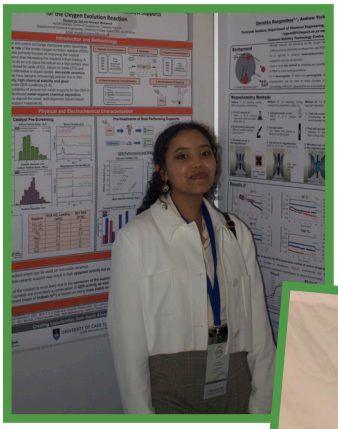
THE CATALYSIS SOCIETY OF SOUTH AFRICA (CATSA)

The Catalysis Society of South Africa (CATSA), with Prof. Nico Fischer as the current Chairperson, hosts its annual international conference in November. Here, students, scientists, researchers, academics, and industry role players across the country, and some parts of the world, gather to share their latest research and findings on catalyst, characterisation, reaction and chemical process development in the form of oral and poster presentations over 3 days. The conference is always hailed as a celebration of the year's achievements and the advancement of South Africa's presence in the world of catalysis.

The conference hosted over 300 attendees in Mossel Bay and the theme of the event was "Catalysts Transcending Chemical and Energy Frontiers". The event was chaired by our very own Prof. Eric van Steen with the help from his team of many UCT students. Most students from the various groups under the Catalysis Institute presented their work, with 2 of our MSc students taking home the most prestigious conference awards:

- Riyazah du Toit (HySA): Best student poster presentation – Title: Investigating the use of Non-Oxide Ceramics as Catalyst Supports for the Oxygen Evolution Reaction
- Candace Eslick (GreenQUEST): Best student oral presentation – Title: Conversion of Dimethyl Ether to C3 and C4 Paraffins over a Pd/Beta Zeolite Catalyst

We'd like to congratulate all students and researchers for taking part in the conference as well as those who took care to organise the event. Thank you for sharing our achievements.



Riyazah du Toit

Candace Eslick

CATALYSIS CENTRE TOASTS TO TWO DECADES

Prof Michael Claeys

After 20 years in accelerating change in the world of catalysis, the University of Cape Town's (UCT) c*change (Centre of Excellence in Catalysis) has reached the end of its funding cycle.

Centres of excellence were established in South Africa's science scene in conjunction with the Department of Science and Innovation, and the National Research Foundation (NRF) to give prominence to essential areas of research. With this agreement in place, the various centres were housed in the country's leading institutions.

"The world of catalysis is inaccessible to most people. Essentially, it explains accelerating chemical reactions of various kinds through a catalyst, or 'sparking' agent," said c*change director, Professor Michael Claeys, at the 20-year celebration function hosted in Tokai, Cape Town.

The occasion also marked the end of its funding cycle, which was initially meant to be for 10 years, but was later extended.

High school physical sciences teachers were invited to learn and inspire their students to persue chemical engineering as a career.

UCT HOSTS GERMAN EDUCATION AND RESEARCH MINISTER FOR UPDATES ON GERMAN-FUNDED RESEARCH PROJECTS

The Catalysis Institute at the University of Cape Town (UCT) recently hosted German minister of Education and Research (Bundesministerium für Bildung und Forschung, [BMBF]), Bettina Stark-Watzinger, and Western Cape premier, Alan Winde, who toured the institute and received updates on two large BMBF-funded green energy research projects underway at UCT. The visit took place on Monday, 27 March.

The two research and demonstration projects are Green-QUEST – which aims to develop a viable, sustainable green fuel product to supplement and eventually replace liquified petroleum gas, and Catalyst Research for Sustainable Kerosene (CARE-O-SENE), which aims to create sustainable aviation fuels.

INAUGURAL PRESIDENTIAL SCIENCE, TECHNOLOGY AND INNOVATION PLENARY

HySA Catalysis and the Catalysis Institute within the Department of Chemical Engineering attended the Inaugural Presidential Science, Technology and Innovation Plenary in December.

The team was given the opportunity to showcase their progress on the production of green fuels/diesel from CO2 and green Hydrogen under the national CoalCO2-to-X Flagship Programme. During this event, they were able to interact with President Cyril Ramaphosa and the Minister of Higher Education, Science and Innovation, Dr. Blade Nzimande.

Professor Patricia Kooyman gave invited lectures at the EMRS (European Materials Research Society conference) in Strasbourg in May and at the Wilbur C. Bigelow Centennial Symposium at the M&M (Microscopy and Microanalysis) conference in Minneapolis in July 2023.

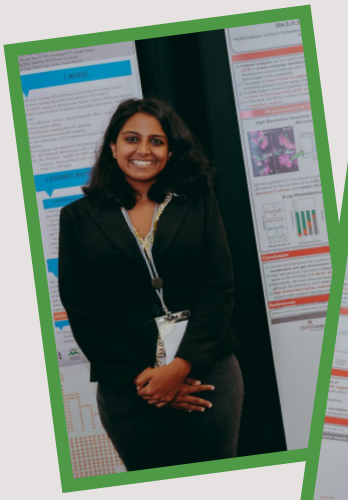
SYNGAS CONVENTION 4

From 2-5 April 2023, the Syngas Convention 4 unfolded at the esteemed Graduate School of Business, organised by the DST-NRF Centre of Excellence in Catalysis c*change hosted by the University of Cape Town under the auspices of the Catalysis Society of South Africa (CATSA). The convention brought together influential minds in the realm of chemical engineering, centering on the synthesis gas production and its conversion, with a specific emphasis on carbon dioxide activation. The conversion served as a hub for academia, industry experts, and innovators to share cutting-edge research, and collaborate on solutions to pressing global challenges.

Researchers from all around the world, engaged in fruitful discussions and shared their research findings. Participants presented their own work in the form of either an oral or a poster presentation. Presentation themes included synthesis gas production, Fischer-Tropsch and methanol synthesis as well as CO2 activation.

A notable highlight from the convention was the acknowledgment of an exceptional student poster presentation. We take pride in announcing that Ms. Percy Ketlogetswe, received the Best Poster Award for her work titled: "Novel empowered supports for the iron-based Fischer-Tropsch synthesis in a power-to-liquids process". Our heartfelt congratulations go out to every student and researcher who contributed to the conference, as well as those dedicated individuals who played a pivotal role in helping to organise the event. We express our gratitude for your involvement and for collectively sharing and celebrating our accomplishments.

Two PhD students, Genna Moss and Ziba Rajan received the top three awards in the PhD section of the poster session at the 2023 International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) Steering Committee meeting hosted by the Department of Science and Innovation (DSI). The poster session was open to various universities from around South Africa and awards divided by degree. In addition, they each also received an iPad and will receive a tour of a hydrogen boat in Cape Town later in the year.



Ziba Rajan

Genna Moss

Professor Cyril O'Connor

ANTOINE GAUDIN AWARD

Professor Cyril O'Connor received the Antoine Gaudin Award from the American Institute of Mining, Metallurgical and Petroleum Engineering for outstanding contributions to minerals processing.

ACADEMIC STAFF & RESEARCH FIELDS

NAME	RESEARCH FIELD
Ms Naseeba Abbas	Energy Systems Research Group – Life Cycle Assessment, Renewable Energy, Circular Economy, Green Hydrogen, Sustainable Development, Environmental and Process Systems Engineering
Dr Kyle Abrahams	Specialising in applying software engineering to solve chemical engineering problems and merging traditional engineering practices with advanced computational methods. Some examples include utilising computer vision for microbiological image analysis, conducting Computational Fluid Dynamics (CFD) simulations to optimise and understand chemical processes, and developing first-principles models
Dr. Amber Abrams	Future Water research institute – transdisciplinary implementation projects in water sensitive design, social sciences and public health research around water, especially surface waters and water bodies; water quality and lived experiences; health vulnerability in the context of extreme weather events; collaborates with Minerals to Metals on social dimensions of mining and mine closure
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 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. Sara Burness	Centre for Minerals Research – Process and applied mineralogy, diamonds, geometallurgy
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
Dr Megan Cole	Minerals to Metals – operationalising the Sustainable Development Goals (SDGs) in mining; mining communities and post-closure transitions; water-energy-land nexus; Environmental, Social and Governance (ESG) risks in mining; spatial analysis; data for sustainable development; water sensitive cities
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 Director – Computational fluid dynamics and flotation cell modelling
Associate Professor 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 characterisation
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

NAME	RESEARCH FIELD
Dr.Terry-Ann Franklin	Provides comprehensive overview of Chemical Engineering course content and overview of curriculum integrity, ensuring alignment with ECSA educational standards
Dr Thobani Gambu	Catalysis Institute – Research focussing on the application of computational catalysis and dynamic catalytic theory in molecular activation and conversion to useful products. Interested in the design of electro-responsive materials for catalytic conversion of small molecules under forced dynamic conditions
Mr Armand Stefan Geldenhuys	Centre for Minerals Research – Flotation plant optimisation, modelling and simulation. Flotation froths. Laboratory measurement and scale-up for model development
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
Dr Sithabile Hlahla	Future Water Research Institute - Water and climate change, and their impacts on human migration trends in Sub-Saharan Africa and on marginalised communities; food systems and the incorporation of neglected and underutilised crop species
Ms Alison Hughes	Energy systems anlaysis, energy systems models, energy efficiency, sustainable energy access, load research
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
Mr Obakeng Jona	Centre for Bioprocess Engineering Research (CeBER); research focuses on biopharmaceuticals development, probiotics, bacterial vaginosis, bioreactor and bioprocess scale-up, microbial growth media design, microbial growth kinetics, microbial characterisation, and fermentation of mageu
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
Professor Alison Lewis (Dean)	Director of the Crystallisation and Precipitation Research Unit – Industrial precipitation and crystallisation, recovery of value from effluent streams, water treatment through crystallisation, process design and integration for water treatment, Eutectic Freeze Crystallisation, 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

ACADEMIC STAFF & RESEARCH FIELDS

NAME	RESEARCH FIELD
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
Associate Professor Malibongwe Manono	Centre for Minerals Research – Flotation reagents, flotation chemistry, water within minerals processing, and dewatering of flotation concentrates and tailings
Ms Kalpana Maraj	Research groups: Future Water Institute and CeBER Research fields: Water quality, nature-based solutions, biological water treatment systems, water reuse, contaminants of emerging concern
Dr Andrew Marquard	Energy and Industrial Systems Research - Field Energy and Climate Policy
Mr Bryce McCall	Energy systems modelling of South Africa's Power, and Industrial sectors using optimisation and simulation modelling platforms. Long-term trends and technology developments in South Africa's industrial landscape in the context of economic development and climate change. The role of producing and using hydrogen for feedstock, and energy. Synergies between different industries, as well as the power sector. Technology and social transitions in the power sector today, and in the future of South Africa.
Associate Professor Belinda McFadzean	Centre for Minerals Research – All aspects of flotation from interfacial interactions and chemistry to froths and full-scale optimisation
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 Rhiyaad Mohamed	Catalysis Institute – Research and development of materials and components for low-temperature PEM electrolyser applications
Dr Thebe Mokone	Hydrometallurgy - Focusing on metal extraction from secondary mineral ores and process development for industrial wastewater treatment
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-Tropsch fixed bed reactors for wax production, plastic to diesel, novel PSA air separation designs, carbon black furnace, beer tunnel pasteuriser and 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
Ms Lerato Motsepe	Crystallisation and Precipitation Unit – Industrial crystallsation for the recovery of valuable products from effluent streams, wastewater treatment using eutectic freeze crystallisation for water recovery. Designing crystallising units for optimal process efficiency
Dr Thulani Nyathi	Catalysis Institute – Synthesis and evaluation of heterogeneous catalysts for carbon monoxide- and carbon dioxide-conversion reactions (e.g., preferential oxidation of carbon monoxide, Fischer-Tropsch synthesis, and carbon dioxide hydrogenation), with a special focus on ex situ and in situ catalyst characteriation

NAME	RESEARCH FIELD
Dr Lisa October	Centre for Minerals Research - Flotation chemistry, water quality in froth flotation, interfacial interactions
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)
Dr Michelle Pressend	Academic Coordinator of TRAJECTS (Transnational Centre for Just Transitions in Energy, Climate and Sustainability) African Regional Hub. She is responsible for the leadership, management, and administration of the project, which involves collaborating with project partners from Colombia and Germany, overseeing the Masters and PhD scholarships, conceptualising and organising the Mobile Schools, Virtual Labs, Virtual Lectures, and Sustainable Transition Dialogues, and conducting research and publications on the social and ecological dimensions of sustainability in energy transitions
Dr Tokoloho Rampai	Research focus is mainly in Materials Engineering, this is applied both in Antarctic sea ice research and advanced ceramic materials development for application in catalysis processes. Under the advanced ceramics research, she focuses on powder metallurgy, thermodynamics for materials development, material properties development and tribological testing for suitability of application. And under the sea ice research she focuses on improving the understanding of the material properties (structural and mechanical) of Antarctic sea ice, predominately through artificial sea ice growth experiments in temperature-controlled laboratory conditions and nominally through field testing in the Marginal Ice Zone in the Southern Ocean
Dr. Shaine Raseale	Catalysis Institute – Development of heterogeneous catalysts for carbon dioxide, hydrogen and light hydrocarbons-conversion through carbon capture and utilisation processes (e.g. carbon dioxide assisted oxidative dehydrogenation, reverse water gas shift reaction and dimethyl ether hydrogenation), with special focus on the application of in situ and ex situ characterisation techniques
Dr Maximilian Richter	Numerical and analytical modelling of granular flows in comminution and classification, particle tracking applications in granular flow systems
Ms Kathija Shaik	Hydrometallurgy Research Group - Extraction of base metals (BMs) and precious group metals (PGMs) from primary and secondary resources, with a focus on electrochemical research to explore fundamental leaching processes
Mr Grant Smith	Energy Systems Research Group. Economics of local government, energy, transport, and other utilities. My research often combines the use of large administrative data sets with experimental, and survey-based methods to understand various problems at the local government level. Currently working on topics in renewable energy, housing, behaviour, and tariffs
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
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 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

ACADEMIC STAFF & RESEARCH FIELDS

NAME	RESEARCH FIELD
Professor Eric van Steen	Catalysis Institute – SA Research Chair in Reaction Engineering, Fischer-Tropsch synthesis, catalytic oxidations, photo-catalysis, molecular modelling of heterogeneous catalytic systems and reaction kinetics
Dr Alta van Zyl	Centre for Bioprocess Engineering Research – Development of vaccine candidates for humans and animals
Mr Jason Waters	Centre for Minerals Research – Comminution and classification (including fine particles processing and rheology)
Dr Nodumo Nokulunga Zulu	Centre for Bioprocess Engineering Research – Algal Biotechnology, Anaerobic Digestion, Bioremediation and Fermentation Technology. In these areas I have worked with bacteria, yeast, microalgae and plants as model organisms in developing product and processes with applications in various sectors. My research focuses on the bioremediation of contaminated streams and the production of valuable bioproducts. These are brought together into biorefinery and circular economy applications

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 and Director of Minerals to Metals Signature Theme – Integrating and expanding capacity in minerals beneficiation research

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	n/a
Honorary Professor Brett Cohen	
Honorary Professor Indresan Govender	Centre for Minerals Research – Particle Technology
Honorary Professor Christopher Hebling	Catalysis Institute – hydrogen technologies, electrolysers and fuel cells, photovoltaic (solar PV) systems and materials, wind energy. Currently the Director of the Hydrogen Technologies Division, Fraunhofer Institute for Solar Energy Systems (Germany)
Honorary Associate Professor Rene Laufer	
Honorary Associate Professor Michael Nicol	Hydrometallurgy
Honorary Professor Jim Petrie	Environmental and Process Systems Engineering – Decision support systems, sustainable energy systems, industrial ecology
Honorary Professor Neville Dennis Plint	n/a
Honorary Professor Malcolm Powell	n/a

NAME	RESEARCH FIELD

HONORARY ASSOCIATE PROFESSORS

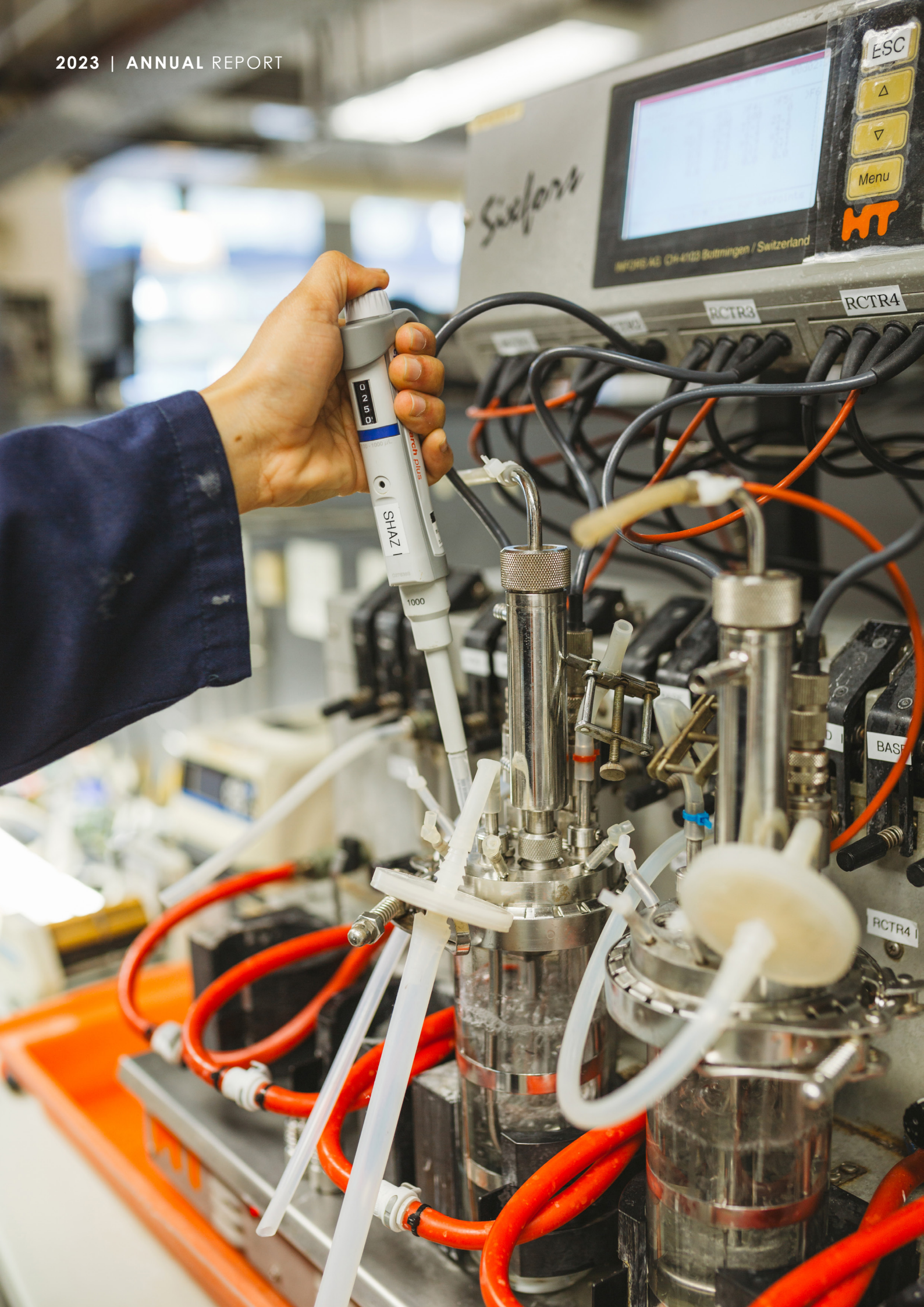
Honorary Associate Professor Jo Burgess	Centre for Bioprocess Engineering Research – Water utilization and treatment in mining and other industries

HONORARY RESEARCH ASSOCIATES

Honorary Research Associate Dr Melinda Dunnett Griffiths	Centre for Bioprocess Engineering Research – Algal bioprocess engineering
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	Centre for Bioprocess Engineering Research – Bioprocess engineering
Honorary Research Associate Mr Hilton Trollip	Field Energy and Climate Policy

ACADEMIC STAFF & RESEARCH FIELDS

NAME	RESEARCH FIELD
ADJUNCT STAFF	
Adjunct Professor May Hermanus	Centre for Minerals Research
Adjunct Associate Professor Pieter Levecque	
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	n/a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PROFESSOR JACK FLETCHER &
PROFESSOR NICO FISCHER

CATALYSIS INSTITUTE (CAT)

The Catalysis Institute comprises three centres, namely the Centre for Catalysis Research, the DSI-NRF Centre of Excellence in Catalysis (c*Change) 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 DSI – 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. With this combination of skills and expertise, the Catalysis Institute is in the unique position to research and develop technologies across the full value chain from green hydrogen generation to its consumption and conversion to sustainable chemicals and fuels. Especially the conversion aspect has intensified the Institute's research focus on the utilisation of carbon dioxide as sustainable carbon source and thereby offsetting fossil fuel emissions. Within this global challenge, the Catalysis Institute is playing a leading role in local and internationally funded research consortia developing catalytic processes for sustainable diesel, cooking gas (LPG replacement), kerosene and shipping fuels. 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 and electrolyser 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.

DSI-NRF CENTRE OF EXCELLENCE IN CATALYSIS (c*change)
The DSI-NRF Centre of Excellence in Catalysis (c*change), established in 2004, is a large yet focused virtual research programme of national scope and significance. It encompasses multidisciplinary participants from 11 higher education institutions, comprising some 16 research groupings from fields in heterogeneous, homogeneous and bio-catalysis, and disciplines ranging from chemistry and engineering to microbiology. The objectives of the Centres of Excellence Programme have been, among others, to promote knowledge and human capital development in areas of strategic importance to South Africa; to promote collaborative and interdisciplinary 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 three distinct research programmes:

- **Paraffin Activation (PAR) Programme (UCT, US, UKZN, UFS)**
- **RSA Olefins (OLE) Programme (UCT, US, UFS, NWU, UJ)**
- **Synthesis Gas (SYN) Programme (UCT, WITS, UWC, UJ, UL, UNISA)**

While the funding cycle for the Centre of Excellence is coming to an end in 2023, after 20 years of continuous operation, the outstanding scientific expertise built within c*change is already driving many of the large research projects within the Catalysis Institute, both with academic and industrial partners.

HySA/CATALYSIS
HySA/Catalysis is one of the three centres of competence that make up the South African Department of Science and Innovation's National Hydrogen and Fuel Cells Technologies Flagship project branded as Hydrogen South Africa (HySA). It is co-hosted by the Catalysis Institute at the University of Cape Town and Mintek. The renewed funding commitment of the DSI demonstrates the key role this Flagship project plays in the national strategy described in the South African hydrogen roadmap, with its ambitious plans to establish a hydrogen valley spanning from Durban in the south, to the platinum mines in the north of the country as well as the Boegoebaai Port and Green Hydrogen Cluster. The overall objectives of HySA Catalysis are to create commercialisable technologies for production of materials and components (precious metal catalysts and membrane electrode assemblies (MEAs), for proton exchange membrane fuel cell and electrolyser stacks for the HySA Programme. The ultimate goal is to establish South Africa as a major global exporter of catalysts and components for hydrogen technologies.

PROFESSOR DAVID DEGLON

CENTRE FOR MINERALS RESEARCH

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 recognised 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 reinstated.

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 optimisation of mineral processing concentrators".

Design, simulation and optimisation 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 optimise 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.

DOCTOR THANOS KOTSIOPOULOS

CENTRE FOR BIOPROCESS ENGINEERING RESEARCH (CeBER)

Bioprocess Engineering is a core discipline within Chemical Engineering. It brings bio-based and nature-mimicking approaches to provide sustainable processes and products. Products cover the full spectrum including material, fuel, metal-based, commodity, fine chemical, agricultural, food, feed, and health products. Bioprocess engineering is ideally orientated for the circular economy. It provides tools for enhancing resource efficiency, enabling effective reuse and recycling, maximising value creation from waste, and minimising harmful waste, with most bioprocesses taking place under ambient conditions. It seeks to contribute to environmental, social, technical and economic sustainability.

The UCT's Centre for Bioprocess Engineering Research (CeBER) builds on a foundation of bioprocess engineering research activity started in the late 1960s, and has been an accredited UCT research grouping since 2001, and reviewed most recently in 2020. CeBER aims to become a global leader in selected research niches, contributing through exploring fundamental insights and developing concepts into real-life options in bioprocesses and bioproducts. It provides an environment in which to advance knowledge, strive for relevance, and achieve excellence in fuelling South Africa's developing bioeconomy. 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 services and solutions. It maintains a diversity of disciplines and backgrounds across its teams of researchers and collaborators to nurture an interdisciplinary and enriched approach to problem-solving.

The vision of the centre is to be an interdisciplinary research enterprise developing bioprocess engineering skills for South Africa and Africa. During 2021, CeBER was home to nine academic staff members, four postdoctoral research fellows and seven support staff. Over 60 postgraduate students were under CeBER supervision for MSc or PhD studies. Our researchers collaborated with researchers in the Faculties of Science, Law, Commerce and Health Sciences as well as across EBE. The aim is to develop our students' expertise in bioprocess engineering and biotechnology principles and practice, involving students in inter- and transdisciplinary research programmes which will develop an orientation to personal excellence and team collaboration, knowledge and technology, society and environment. This happens in tandem with developing new knowledge and insights and translating these to application.

CeBER is recognised for its strong interdisciplinary focus, integrating biological understanding and process-engineering systems.

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 works together with the Minerals to Metals and Future Water IDTD research groupings within UCT. The centre was also part of the UCT Community of Practice II which included economic and legal sectors. CeBER is one of five UCT research groups involved in the flagship university-wide Sustainable Campus Project which began in 2021. During 2023, the Centre was involved in projects collaborating with universities in Brazil, Chile, Japan and Europe, as well as two multi-collaborator European Union Horizon 2020 projects.

PROFESSOR ALISON LEWIS

CRYSTALLISATION & PRECIPITATION RESEARCH UNIT (CPU)

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 crystallisation 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:

- Novel materials and directed crystal engineering to continuous EFC applications, MSc
- Innovative processes for rare earth element recovery from wastewater, MSc
- Using CO2 for MnCO3 precipitation processes, MSC
- Novel crystalliser designs for EFC, MSc
- REE recovery from synthetic NiMH battery sulfuric acid leach liquors: testing seeds, 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
- Recovery of rare earth elements from low-tenor solutions, PhD

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 – South Africa's leading authority on energy systems

The Energy Systems Research Group at the University of Cape Town combines modelling of energy and economic systems with policy analysis and field-based research, to generate and enhance knowledge of energy systems at sectoral, regional, national and sub-continental scales, focused on South Africa and the SADC region.

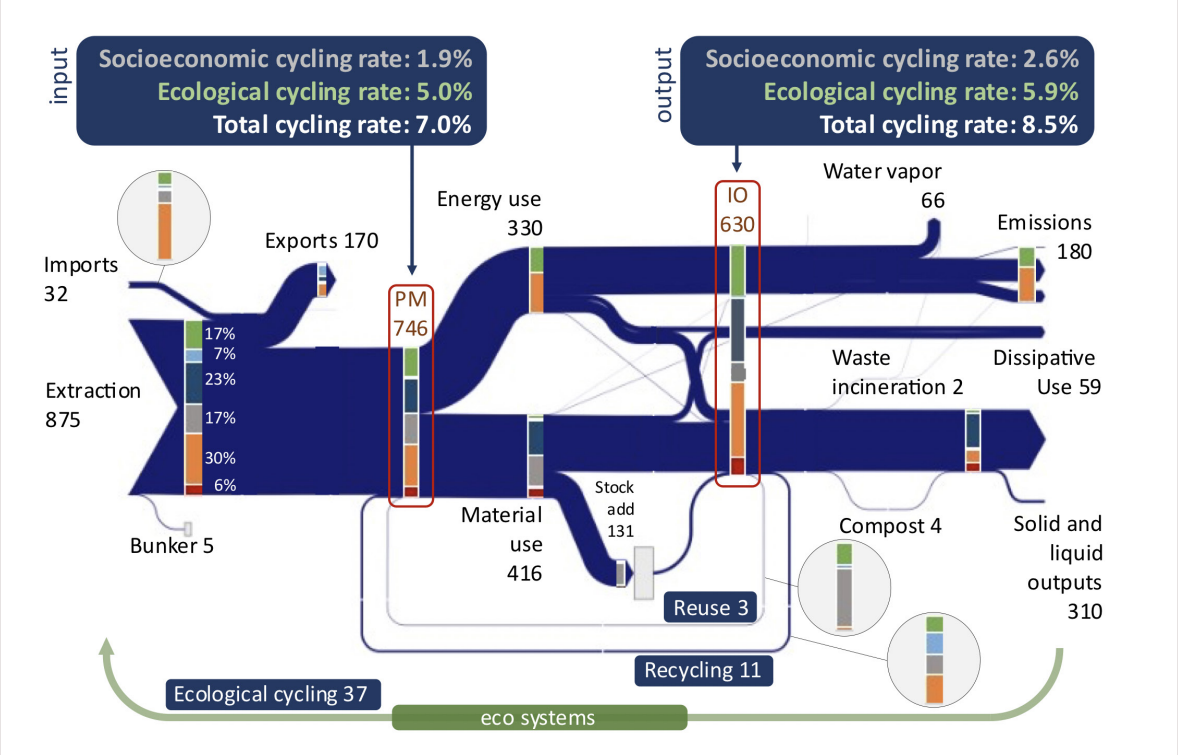
Such large systems are known to behave counter-intuitively, and modelling helps to study the interaction of multiple components under changing conditions over longer time periods, providing intelligence needed for policy regulation and on optimal capital investment into costly infrastructure.

In SATIM, the group holds the only full energy sector model for South Africa, combining electricity and liquid fuels sectors on the supply side with industrial, transportation and residential users on the demand side. A dynamic linking of this energy systems model with a macroeconomic general equilibrium model, called SATIM-GE, allows for economic analysis of energy-system decisions and ensures that inputs to SATIM are based in economic forecasts rather than arbitrarily specified. Specialists cover the main industrial sub-sectors, transport, residential, power generation, coal-mining and renewables. In addition, the group has expertise in modelling on a number of other open-source energy systems platforms.

In 2022, the ESRG completed a first investigation of the possibility of net-zero greenhouse gas emissions from South Africa's economy by 2050. Key members of the group also contributed to the structuring of the Just Energy Transition Partnership deal.

STATE OF CIRCULARITY OF SOUTH AFRICA'S ECONOMY MAPPED
In another first for South Africa, Prof. Harro von Blottnitz collaborated with researchers from the University of Soil Sciences in Vienna, Austria, to map material flows for South Africa's economy and develop indicators of circularity. The result: South Africa's economy is highly linear, as shown in this diagram. All flows in millions of tons (Mt), for 2017.

Material Flows, RSA 2017



A/PROF KIRSTY CARDEN
(CIVIL ENGINEERING DIRECTOR)

FUTURE WATER: UCT'S WATER RESEARCH INSTITUTE

The transdisciplinary research institute, Future Water (http://www.futurewater.uct.ac.za/), was founded in 2016 in response to UCT's call for the development of critical inter and transdisciplinary research initiatives. Future Water is hosted by the Faculty of Engineering and the Built Environment, but the core research team brings together academics from five of UCT's faculties, and at least nine different departments. These include Chemical Engineering, Civil Engineering, Environmental Humanities, Architecture Planning and Geomatics, Environmental and Geographical Sciences, Public Law, Economics 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 scholarships as well as multi-stakeholder and user perspectives. Using this approach, we aim 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 AFFILIATED RESEARCHERS IN CHEMICAL ENGINEERING
CeBER – Thanos Kotsiopoulos, Juarez Amaral-Filho, Catherine Edward, Elaine Govender, Nodumo Zulu, Tynan Marais
CMR – Kirsten Corrin
EPSE – Harro von Blottnitz
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 designing cost-effective water monitoring systems by working with multiple partners.

RESOURCE RECOVERY FOR THE CIRCULAR ECONOMY

Shifting from 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 Theme research projects, with the aim of integrating, enhancing and expanding capacity to facilitate sustainable exploitation, development and utilisation of mineral resources within Africa and beyond. The vision of Minerals to Metals is to play a leading role in the global minerals 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 and A/Prof Jennifer Broadhurst as directors, 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 Dr Megan Cole as a researcher, as well as Adjunct Professors Michael Solomon, Caroline Digby, May Hermanus and Thabani Mlilo. 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 programmes. 2023 saw the re-launch of the Leaders in Extractives in Africa (LEAD) programme in collaboration with Mining in Africa Indaba, hosting 16 young professionals from the African continent exploring the sustainable extraction of minerals on the continent, within the context of the African Mining Vision for a one-week intensive programme at UCT, followed by intensive engagements at the Mining Indaba in the second. The programme is sponsored by Anglo American, GIZ and BGR as well as Mining Indaba and is set to continue on an annual basis in alignment with Mining Indaba.

PROFESSOR JOCHEN PETERSEN

HYDROMETALLURGY (HYDROMET)

The Hydrometallurgy Research Group (Hydromet) formed in 2016 under Professor Jochen Petersen's leadership. It has now grown into an internationally well-recognised research grouping with research into extraction from both primary and secondary resources.

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 (thiosulphate, 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 ongoing support of Hon. Prof Mike Nicol who also came on a research visit in 2023. 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 extraction of zinc, copper and nickel from base metal sulphide ores, ion exchange, extraction of rare earth metals and metals recovery from e-waste. Hydromet collaborates widely within the department and internationally. Some key collaborations occur within in the Minerals to Metals Initiative, which Prof Petersen continues to lead as Director.

Several projects in the area of metal extraction from e-waste have received significant funding from both national and international agencies. In particular, Prof Petersen chairs the NRF Community of Practice 'Waste to Value' which brings together 5 SARChI Chairs in waste management and value extraction (currently in Phase 2, 2023-24). A new collaborative project 'Short Circuits' was applied for and awarded from the Volkswagen Foundation in Germany to a consortium that includes the Hydromet team to develop a complete integrated process for the sustainable extraction of values from electronic circuit boards (2024-2027). As a participant in the European Union's Horizon 2020 Marie-Sklodowska-Curie RISE Action 'ChemPGM' around the PGM value chain (2021-2025), Hydromet has hosted at UCT visitors from Greece and Belgium, and Prof Petersen spent himself a month in Athens as guest of one of the partner companies.

The Hydromet group has published 5 articles in peer reviewed journals and 4 peer reviewed conference papers in 2023; 1 PhD and 4 MSc students graduated in 2023 ceremonies. Prof Petersen attended in person at 2 international conferences, including a keynote lecture at the PbZn2023 conference in Changsha, China. During his sabbatical Prof Petersen spent 3 months as Visiting Scientist at CSIR Minerals Resources in Melbourne, Australia, September to November 2023.

THE PUBLICATIONS

JOURNAL ARTICLES

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Published on behalf of the
University of Cape Town's
Department of Chemical Engineering
by SG Designs
sambrijlal@gmail.com
083 552 2103

Photography Candice Mazzolini