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EBE
Postgraduate Student Council

Sakhela iAfrica (Building for Afrika)

2018 EBE
Postgraduate Research Expo

Towards a sustainable society

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PROGRAMME

Date:	9 May 2018
Venues:	NEB foyer (NEB F) and Snape Lecture Theatre 1 (SLT1)
Start time:	17:00 for 17:30 (at Snape Lecture Theatre 1)
MC:	Michael Odidi

16h30	Exhibition and poster/model viewing by judges (NEB F)
17h40	Welcome into EBE research by Deputy Dean (Postgraduate and Research) (SLT1) *Professor Azeem Khan*
17h50	Institutional Innovation and transformation by Deputy Vice Chancellor (Research and internationalisation) (SLT1) *Professor Mamokgethi Phakeng*
18h00	Importance of Research to industry by Director - Innovation & Transformation, Africa, Aurecon (SLT1) *Mr Abbas Jamie*
18h20	Introduction of Students Presenting Research (NEB F)
18h35	Exhibition and poster/model viewing by guests (NEB F)
19h05	Prizes for best posters exhibited (NEB F)
19h15	Vote of thanks (NEB F) *Bonolo Skee*
19h25 – 20h45	Walk-around (Poster viewing, serving of refreshments and networking) (NEB F)

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WELCOME ADDRESS

Dear EBE Postgraduates, Undergraduates, Staff, Friends and Invited guests

Bagaetsho dumelang!

On behalf of the EBE Postgraduate Student Council (EBE PGSC), I would like to welcome you to this, our fifth EBE Research Expo. The Research Expo aims not only to showcase the work that is done in the faculty, but also provides a platform for collaboration, networking and, most importantly, that allows us to engage deeply about the questions that we are and are not asking ourselves.

Inequality, population growth, limited resources, degraded and degrading ecosystems and questionable leadership are but a few of the complexities which threaten our ability to sustain ourselves, for nature to sustain itself and for nature to sustain us. Thus, it has become increasingly important that we, as researchers and influencers of the future, think of ways to move towards a sustainable future.

With the theme being “Towards a sustainable society”, we hope that this Research Expo will provide a platform for us to interrogate and expand our understanding of what falls within our engineering and built environment profession by welcoming these complexities into our space.

We are excited to meet you.
Pula!

Bonolo Skee

Chairperson
2018 EBE Postgraduate Student Council

MEET THE 2018 EBE PGSC TEAM

CHAIRPERSON

Bonolo Skee

Bonolo is studying an MPhil in Sustainable Mineral Resource Development. Her research focusses on how the effect of mining on water affects the linkages that exist among rural and urban areas.

Her life goal is simple – she wants to add value in the spaces that she has the privilege of entering.

VICE CHAIRPERSON & TRANSFORMATION

Avu Maake

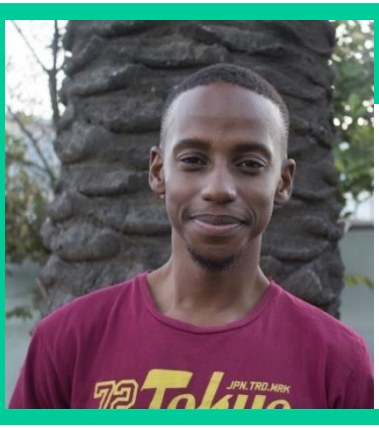
Avu Maake is studying an MSc Civil Engineering. Her research aims to improve wastewater treatment plant simulation models by generating data on the path of phosphorus through various systems. She is passionate about the advancement of black women and other historically disadvantaged groups, especially in the field of engineering.

SECRETARY GENERAL

Prospect Motsi

Prospect is a professional civil engineer with varied experience including roads, land development, building design, underground construction and project management and is a adept at contract law, building regulations and design codes within the Southern African context.

He aspires to lead project management teams for infrastructure projects that add value to society.



TREASURER

Reuben Dlamini

Reuben is studying an MPhil. in Sustainable Mineral Resource Development. His research is focused on developing resource intensity trends of the South African Ferrochrome Industry.

In the council he is sometimes known as “Tito” named after the first black Governor of the South African Reserve Bank (Tito Mboweni).

ACADEMIC CHAIR

Thabo Tlou Mabuka

Thabo is studying a Master’s in Chemical engineering specializing in bioprocessing. His project focuses on metal recovery from electronic waste. He is passionate about justice, equality and liberty.

Most of his life goals are centred around these ethos and he wishes to establish a research group, NGO and pharmaceutical company and transform the medical industry in Africa.

CORPORATE LIAISON

Tariroyashe G. Marufu

Tariroyashe’s research is on indoor navigation paradigms with a particular focus on algorithm design and inclusion of various constraints in the process. Through her academic pursuits she has seen need to continually refine her life goals and aspirations. She plans to use this as a spring board towards practicing as a professional in geomatics and project management.

MARKETING

Lelia Lelia

Lelia is currently pursuing an MPhil in Sustainable Mineral Resource Development under the Minerals to Metals Initiative.

His research focuses on post-mining land use transformation and rural-urban linkages as a way of improving the contribution of mining companies to developing sustainable mining communities post closure.

PUBLICATIONS

Zarmeen Ghoor

Zarmeen is studying an MSc Eng in Civil Engineering. Her research involves identifying and comparing different ways to use Cape Town's wastewater as a water resource. This involves investigating the potential of water reclamation, assessing the potential to use treated wastewater effluent as a water source for non-potable applications and how these could add to Cape Town's water supply.

OUTREACH AND SOCIAL RESPONSIVENESS

Danielle Seeger

Danielle is currently doing an MSc in Bioprocess Engineering. Her major focus of this exciting field is the investigation of novel approaches for the sustainable production of fine chemicals. She is keen to participate in projects undertaken by a diverse and inter-disciplinary team of people as this can be a powerful approach to solve societal, economic and environmental challenges.

INTERNATIONAL AND PART-TIME STUDENTS

Yandisa Sizamo

Yandisa is studying an MEng Telecommunications. His research is about creating Digital Smart Cities.

His passion is to make a positive contribution towards the betterment of others.

*"Our vision is to be **visible**, serve, challenge the status quo and to be **afro-centric**"*

2018 EBE PGSC

EVENTS CO-ORDINATOR

Alexandra Himunchul

Alexandra is studying a Master of Philosophy specialising in Sustainable Mineral Resource Candidate. Her research centres around how trans-disciplinarity may be used in the creation of T-professionals. Her passions include education and sustainability.

THEME: TOWARDS A SUSTAINABLE SOCIETY

As a human species we have often grappled with the thought of our existence and survival. The very essence of our core points towards sustaining our selves however the progress we have made in what we regard as development has come with detrimental consequences.

The question we may pose is what is sustainability? A philosophical debate is always had with this term which has garnered numerous definitions. However, the world has come to agree that this term somewhat has the meaning of "the ability to maintain a certain level". The preceding points on debates emerging from the questions of what/where is that level we call sustainable? Sustainability therefore is a huge discourse which cannot be tackled without the consideration of all schools of thought, even the ones we regard as traditional. For those traditional customs have sustained us before and ensured our survival. We are in uncharted waters in the ocean of development and it is imperative that we understand the depths of our own journey in the path of development.

Therefore, it stands to reason that before we can define sustainability and come to terms with is importance. It is imperative to define our own identity. Unfortunately, identity is accompanied by historical narratives with issues which cannot be avoided voluntarily or involuntarily. The dark past which we ever feel so present in Africa is a crucial element that we need to consider in our road towards a sustainable society. Africa's identity has been marred by negative external interference but here she still stands home to over 54 countries with over 1.25 billion people. With a rich vibrant culture that dates back to the ancient time, full of knowledge, great wealth in nature, culture and customs.

The role of unmasking Africa's identity lies in understanding her history particularly with development. While the current world order was being forged, Africa was in prison during colonialism. Therefore there remains a lot of untapped potential in Africa which cannot be unmasked without research work.

For genuine sustainability in Africa and in the world, a common objective must be reached in which every individual element is a stake holder. This lies in the values that the liberal world has declared with regards to democracy and rights. The issues in sustainability are not just an environmental threat only but incorporate social

sustainability as well. The Engineering & Built environment (EBE) has played a fundamental role in the development of the current civilization we share today. Which is a contribution of many cultures, spanning millennia of research into how we utilize our environment and relate to each other to sustain our needs and survival. Therefore, the role of that EBE has to play in contributing towards a sustainable society is fundamental research which not only seeks excellence in its field but convergences all disciplines. Research in Africa is crucial in unlocking her identity thereby understanding what it means for her to be sustained.

As researchers we have a huge responsibility to usher in knowledge that not only brings about focal development but development with a wide lenses to encompass all the elements, to not only be excellent in a single discipline but to excel in all disciplines within the spheres of school of thoughts. To be more critical of our research outside the walls of science and to constantly question our moral stature. For we have no choice but to walk towards "a sustainable society."

CELEBRATIONS

As we journey forward towards “a sustainable society” it is also important to acknowledge the work that the people in and around our communities are doing. It is important to celebrate strides we make particularly in EBE toward the goals of sustainability and the individuals that lead those strides.

PROFESSOR DEE BRADSHAW

Professor Dee Bradshaw grew up in a small town in Zimbabwe. She won a place to study at UCT where she enrolled in a science degree. She obtained her PhD in 1997 in Chemical Engineering from the University of Cape Town (UCT) and went on to be a research officer and associate professor at UCT. She was encouraged to start a PhD examining surfaces and flotation (synergistic effects between thiol collectors used in the flotation of pyrite). This equipped her with technical skills to apply as a researcher and lecturer during the platinum boom.

During her sabbatical, she was pushed out of her comfort zone in the development of the EnviroGem project where she worked with a completely new team of researchers. This sparked her deep passion for research supervision which she continued to develop during her time in Brisbane. Professor Dee Bradshaw recognises that postgraduate students are in a space of transformation, they are performing research that will ultimately transform a society. She has been responsible for initiating, setting up and participating in post graduate courses in flotation chemistry, process mineralogy, geometallurgy and building research capacity in general at the UCT amongst other universities.

Although she recognises herself as an accidental academic, Prof Dee Bradshaw garnered 30 years in Flotation Chemistry and Process Mineralogy with her interests expanding into other aspects of the field as she continues to work towards the 'Development of an Integrated Mineralogical Framework for Mineral Processing". She was the Liberation and Recovery project theme leader on the AMIRA P843A project which ended in July 2013. Dee Bradshaw is the UCT hosted South African Research Chair: Mineral Beneficiation at the University of Cape Town (UCT) and the Director of UCT's Minerals to Metals Signature Theme. She is also an Honorary Professor at the Sustainable Minerals Institute at The University of Queensland (UQ) Amongst her many achievement Prof Dee Bradshaw has touched many lives in the EBE Faculty. She launched the book 'Green Mining, Beyond the Myth' which addresses the social, economic, cultural and political issues surrounding sustainable mining, and explores pathways to a better future for the mining industry.

Her outstanding efforts were acknowledged by the University of Queensland in 2013 where she received an award for Excellence in Research Higher Degree Supervision.

This article is an exempt of the article written by MEI Rising Star Dr. Anita Parbhakar-Fox, of the University of Tasmania, who recently interviewed one of mineral processing's leading researchers Prof. Dee Bradshaw. The original piece can be found on the MEI Blog:
http://min-eng.blogspot.co.za/2018/03/international-womens-day-celebrating.html

CHEMICAL ENGINEERING

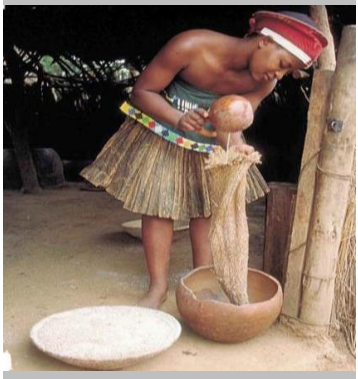
The Department of Chemical Engineering at UCT is one of six Departments in the Faculty of Engineering and the Built Environment.

The Department offers a four-year BSc (Chem Eng), as well as Master's and doctoral degrees. The MSc (Chem Eng), Phil and the PhD may all be pursued by dissertation only.

There is also an option to pursue the MSc (Chem Eng) and MPhil by a combination of structured coursework and dissertation (60 credits coursework and 120 credits dissertation).

The Department of Chemical Engineering is noted for its vigorous research activity (which is evident in the number of university-accredited research groupings that it hosts), as well as its large number of registered postgraduate students.

Africa has been pioneering chemical engineering for a very long time…



A Zulu woman brewing beer known as "Umqombothi"

Iron work at Mjimwema, Njombe Tanzania in an ancient iron furnace from the 1400s

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CONSTRUCTION ECONOMICS & MANAGEMENT

Research and allied scholarly work in the Construction, Economics and Management Department falls under two broad themes of property and construction. Five research groups examine issues related to infrastructure delivery, construction industry development, wellness in construction, emerging property markets, and facilities management. A number of cross cutting themes provide diversity and smaller research interest groups; these themes include sustainability, project management, human development, property markets and property valuations, procurement, and teaching and learning. The Department is home to the recently formed UCT-Nedbank Urban Real Estate Research Unit.

Strong research links exist with academic institutions in the United Kingdom, Italy, United States of America, Nigeria, Central and East Africa, as well as with institutions within South Africa. In 2017, a number of papers were published in peer-reviewed local and international journals, frequently with international co-authorship, underscoring the Department's international profile and collaborative research philosophy.

The Department continues its engagement with local and international professional organisations; industry; and government and state organisations. Research endeavours by individual staff have been good in terms of higher degree graduates, attracting research funding, and research outputs. The staff received research funding from a variety of sources in 2017, namely: the University Research Committee (URC), the National Research Foundation (NRF), the Construction Industry Development Board (CIDB), and Nedbank Corporate and Investment Bank (Property Finance Division). In addition, the department boasts a "B2" and a "C2" NRF-rated researchers.

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ELECTRICAL ENGINEERING

Electro technologies make a profound impact on us as individuals and as a society. These technologies revolutionise the way we live; they shift our cultures, our economies and our development.

New forms of technology, which were once unimaginable, and achieve what once seemed impossible, are emerging every day. At the Department of Electrical Engineering at the University of Cape Town we are at the cutting edge of research and teaching, not just in South Africa, but across Africa and globally.

We aim to produce graduates who are innovative and capable of becoming the leaders in their fields. Our students are given an excellent foundation in the principles of electrical engineering. From this base, they develop the ability to conceptualise, and to analyse and solve problems.

Our department's research projects cover a wide range of subjects, including the investigation of novel computer systems, the simulation of electricity markets, the use of computer control and instrumentation to optimise process performance, ecologically sustainable power generation, radar sensors and telecommunications. We focus on working closely with industry so that the department remains at the forefront of electrical engineering trends worldwide.

Become a part of our creative and stimulating degree programmes where we aim to solve the very problems whose articulation and analysis is our focus.

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CIVIL ENGINEERING

The Department of Civil Engineering at the University of Cape Town has an international reputation for excellence in research and teaching. It offers a four-year BSc (Civil Engineering) degree programme and several taught postgraduate programmes, as well as supervised research studies leading to Master's and Doctoral degrees. The current enrolment is 532undergraduate students, 224 postgraduates and 6 post-doctoral Fellows – giving a total of 762 students.

Postgraduate teaching and research is conducted within the framework of well-established research groups in the areas of Structural Engineering and Mechanics, Geotechnical Engineering, Concrete Materials and Technology, Hydraulic Engineering, Water Quality Engineering, Urban Water Management and Transport Studies. Members of staff are part of university accredited research groupings which include Future Water; Urban Water Research Unit, Concrete Materials and Structural Integrity Research Unit (COMSIRU); Centre for Research in Computational and Applied Mechanics (CERECAM); Centre for Transport Studies and the African Centre for Cities (ACC).

The Department has fruitful collaborative links with several local and overseas universities, and with local industry. Much of the work done by members of staff finds application in industry. The high quality of the research undertaken by the Department is evidenced by the considerable number of peer-reviewed publications in ISI-accredited international journals produced by members of staff annually, and the international recognition that members of staff enjoy in their areas of research. Members actively participate on the committees of local professional bodies, provide expert advice to industry, and serve on the editorial and advisory boards of various international journals and conferences.

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ARCHITECTURE, PLANNING & GEOMATICS

The School of Architecture, Planning & Geomatics at the University of Cape Town is uniquely situated in the context of sub-Saharan Africa Universities, as it is the only one offering a wide variety of built environment programmes: Architecture, Landscape Architecture, Cities and Regional Planning, Urban Design, Conservation of the Built Environment, Geomatics and Land Surveying.

Based at a leading African University, with over 600 students and 30 full time academic members of staff, the School seeks to be a laboratory for engagement, and in itself potentially represents the global south metropolis in miniature. Within this richly diverse context, students learn to define themselves as they progress through the curriculum, working toward ever greater levels of independence in their research, writing, and design.

Beyond the School, Cape Town provides the inspiration and the test ground for our work, allowing students to learn in the context of one of the continent's more complex metropolises. The work of its students and graduates has consistently been prized and recognised in national and international forums, and is at the forefront of engaged scholarship in a meaningful and critical way that can support the spatial and social transformation process of South Africa.

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MECHANICAL ENGINEERING

The Mechanical Engineering Department at UCT offers several postgraduate programmes from Honours through to PhD level covering a range of research areas.

These include: bio-engineering; materials characterisation; blast resistant structures; metal alloy development; high performance machining and manufacturing; composite materials processing; computational solid mechanics; computational fluid dynamics; aeroelastic and free-surface modelling; heat transfer optimization; power plant thermofluid process modelling; power plant materials behaviour; non-destructive evaluation of materials and structures; robotics; poverty alleviation, energy and developmental needs; climate change mitigation; engineering management and systems theory; and engineering education research.

Observers look at Therese Izay Kirongozi's Traffic robot regulator. Therese is from Kinshasa.

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RESEARCH GROUPS IN EBE

African Centre for Cities

The African Centre for Cities (ACC) is an interdisciplinary research and teaching programme focused on quality scholarship regarding the dynamics of unsustainable urbanisation processes in Africa, with an eye on identifying systemic responses. The ACC aims to produce credible new knowledge on the drivers of urban crisis in African cities with an eye on systemic solutions

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AFRICAN CENTRE FOR CITIES
urbanism from an african perspective

Blast Impact and Survivability Research Unit

With the ever-increasing potential for injuries and fatalities from impact and blast events, the research focus of the BISRU centre is to reduce risk of injury and save lives through engineering research. Most of the research carried out in the centre is inter-linked ranging from blast and impact loading of structures to material characterisation of composites, metals and biological materials (bones). BISRU is one of the few academic centres in the world where a blast chamber, Hopkinson bar facilities and drop testers are located within one footprint.

genevieve.langdon@uct.ac.za

BISRU

Centre for Bioprocress Engineering Research

CeBER strives to equip scientists and engineers at the postgraduate level with expertise that will allow them to excel in every area of the bioprocess arena and its associated sectors by using bioprocesses such as waste treatment, environmental engineering, minerals, chemicals, food and pharmaceuticals.

Our primary research areas include Algal Biotechnology, Bioproducts, Biominerals and Water & The Environment.

CeBER@uct.ac.za

Centre for Catalysis

The Centre for Catalysis concerns itself with both fundamental and applied research and development in the field of heterogeneous catalysis – encompassing all molecular modelling, catalyst synthesis, physico-chemical characterisation and performance evaluation for industrially interesting chemical conversions. The principal fields of investigation include Fisher-Tropsch synthesis, fuel processing chemistries, zeolite/acid catalysis and catalysis by platinum group metals and gold.

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UNIVERSITY OF CAPE TOWN
CENTRE FOR CATALYSIS RESEARCH

Centre for Minerals Research

The Centre for Minerals Research (CMR) is a multi-disciplinary, inter-departmental Research Centre with close collaboration with groups in the Department of Physics, Mechanical Engineering and the Centre for Research into Computational and Applied Mechanics (CERECAM).

The Centre for Minerals Research conducts research in the areas of comminution, classification, froth flotation and process mineralogy.

cmr@uct.ac.za

CENTRE FOR MINERALS RESEARCH

Centre for Research in Computational and Applied Mechanics

The membership of Cerecam comprises academic staff members, postdoctoral researchers and postgraduate students from four departments in EBE and the Science Faculty. The principal objective of Cerecam is to provide a coherent focus and point of interaction at UCT for research and applications in mechanics by promoting and supporting fundamental research, applied research, and industrial interaction in computational and applied mechanics and associated disciplines.

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cerecam
Centre for Research in Computational and Applied Mechanics

Centre for Research in Engineering Education

The Centre for Research in Engineering Education (CREE) was founded in 1996, with the aim of establishing and promoting engineering education as a viable research field at UCT and in the broader academic community. From its beginnings in engineering education at UCT, CREE has broadened its scope of interest to include educational research in the tertiary sciences and related disciplines. The Centre seeks to develop theoretically informed and research-based ways of understanding teaching and learning in engineering, tertiary science, and related disciplines.

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Cree Centre for Research in Engineering and Science Education

Centre for Transport Studies

The Centre for Transport Studies is a multidisciplinary research and postgraduate teaching body. The purpose of the Centre is to stimulate debate and undertake research that focuses on the equity, sustainability and efficiency problems associated with urban passenger transport systems in South African cities, and on the development of practices and skills that are consistent with the goals and objectives of contemporary and progressive policies. The Centre's priorities in curriculum development, and in undertaking research, are to contribute to the equitable, efficient and safe accommodation of the travel needs of poorer households within urban passenger transport systems, and to the promotion of more efficient and sustainable travel behaviour patterns and transport system operations.

roger.behrens@uct.ac.za

CENTRE FOR TRANSPORT STUDIES
Faculty of Engineering and the Built Environment

Concrete Materials and Structural Integrity Research Unit

The Concrete Materials and Structural Integrity Research Unit (CoMSIRU) is a major research entity in the Department of Civil Engineering at the University of Cape Town. The unit's research is focused on quality, durability and sustainability of concrete construction, structural health monitoring, structural integrity assessment, and repair & rehabilitation strategies for concrete structures. "The guiding principle for CoMSIRU is developing high-level manpower for industry, research and academia, while engaging in innovative and impactful research. We endeavour to foster a collaborative attitude, critical thinking, and independent views among students and encourage them to work in teams wherever possible.

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Crystallisation and precipitation Research Unit

The main aim of the Crystallisation and precipitation Research Unit is to advance existing fundamental knowledge in the fields of crystallization and precipitation, especially related to the South African and International mineral processing and extractive metallurgy industries. The unit focuses on two main areas of research which are optimising precipitation in hydrometallurgical processes and development of innovative technologies for mining wastewater treatment. Research Focus and Project Areas include eutectic freeze Crystallisation, rhodium deta precipitation fundamentals of precipitation processes in water treatment, metal sulphide and hydroxide precipitation and selenium precipitation thermodynamics and kinetics

crystal@uct.ac.za

Energy Research Centre

The Energy Research Centre is a multi-disciplinary research centre which pursues excellence in technology, policy and sustainable development research, education and capacity building programmes at a local and international level. The ERC has led the development of South African energy policy throughout the transition to democracy. The interdisciplinary mix of the Cente'rs staff enables us to provide balanced insight into energy problems pertinent to Africa. This is reflected in the major research focus areas, which are energy, poverty and development, energy efficiency, energy systems analysis and planning, energy, environment and climate change and renewable energy.

ERC
ENERGY RESEARCH CENTRE
University of Cape Town

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Environmental & Process Systems Engineering

The Environmental & Process Systems Engineering (E&PSE) work on environmental issues of the resource-based process industries, and explore the use of process and systems engineering skills to solve environmental problems in development contexts. We engage with the diverse worlds of the New Product Developer, the Process Design Team, the Environmental Engineering Consultancy, the Corporate Sustainability Analyst, the Urban Sustainability Analyst and the Environmental Regulator, wherever they are concerned with the processing of Biomass, Water, Recyclables or Minerals. Their challenges are to create opportunities, back them with efficient technology, and influence their organisations or clients to make decisions that help our society to develop sustainably. Our work is strongly incorporated into two signature research themes of the University of Cape Town: ‘Minerals to Metals’ and ‘African Urbanism’. Equally, we have a strong collaboration with the national Biofuels research chair at the University of Stellenbosch.

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Future Water

Future Water is a transdisciplinary research institute at the University of Cape Town that addresses issues of water scarcity in South Africa. It recognizes the importance of integrating technical, social, environmental and economic perspectives towards robust sustainable solutions. To this end the Institute provides the space for discipline specialists as well as generalists across the faculties of Humanities, Law, Commerce, Health Science, Science, and Engineering and the Built Environment to interact and develop approaches aimed at addressing critical issues, holistically and together. Current research focus areas include, inter alia, groundwater, water treatment, water supply, sanitation and drainage, wastewater treatment, acid mine drainage, water recycling, water sensitive design, water economics, water equity, water governance, water and health.

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Minerals to Metals

The Minerals to Metals Initiative was born of the realisation that making mineral beneficiation activities more sustainable means that the selection, design and operation of minerals-to-metals processes and technology options must take place within the context of environmental, economic and socio-political considerations. Minerals to Metals has research areas in acid rock drainage mitigation, energy optimization, mine safety projects, mineral beneficiation, mineral carbonation, process optimization, mineral value chains, strategic minerals, technical innovation, value from waste and licence to operate

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EBE Postgraduate Student Council Research Group

The EBE postgraduate student council research group is a student centred research group run under the EBEPGSC.

This research group was established in 2018 and focuses its research in multi-disciplinary issues regarding students. In 2018, the research group is focusing on its first report which is titled “The student cost of living and funding outlook”.

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EBE POSTGRADUATE STUDENT COUNCIL RESEARCH GROUP

UCT-Nedbank Urban Real Estate Research Unit

The main aim of the UCT-Nedbank Urban Real Estate Research Unit is to provide a unique inter-disciplinary research platform for academia that promotes the identification of issues and seeks solutions to urban real estate. The unit focuses on four main areas of research urban Real Estate Markets, Dynamics and Trends. urban Real Estate Investment and Finance. Urban Land Economics and Management. and African Urban Real Estate Markets.

The research focus and project areas include residential real estate markets, commercial real estate markets, urban management and African urban real estate markets.

ureru@uct.ac.za

URBAN REAL ESTATE RESEARCH UNIT

AARON GRAHAM

I have always had a lot of questions. My entire life has been spent looking for answers, with each answer leading to further questions. This, combined with an enjoyment of mechanical systems, led to my starting an undergraduate Mechanical Engineering degree at UCT.

"I have always had a lot of questions"

I greatly enjoyed the sense of discovery and achievement that I got from my final year research project (design, build, test of a prototype 2 stage gas gun), as well as my more mathematical coursework. As a result, I decided to sign up for an MSc. by dissertation and coursework, in order to continue with the process of research and discovery.

Supervisor
Dr Reuben Govender

Department
Mechanical Engineering

Research Title
Design of a novel high strain rate bi-axial tension test device for biological membrane tissue

ABSTRACT

Skin is a highly complex non-linear, anisotropic biological material composed primarily of collagen and elastin fibres. Skin is highly compliant at low strains, but increasingly stiff at high strains and remarkably tear resistant. The mechanical properties of skin are highly dependant on orientation relative to Langer's lines (lines of natural tension in the skin). Whilst the mechanical properties of skin are well known at low strain rates and low strains, there has been relatively little research into high strain rate mechanical properties of skin. The vast majority of high strain rate testing of skin has been uniaxial, however it has been shown that uniaxial tensile testing of skin poorly approximates *in vivo* behaviour of skin [1,2] . This project makes use of a high strain rate bulge test as a bi-axial tension test method.

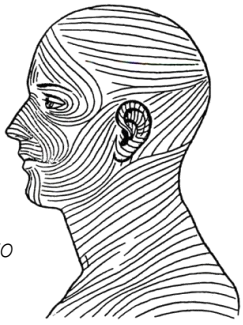

Figure 1: Langer's lines

This approach has two primary advantages:

- The use of Digital Image Correlation (DIC) and bulge testing allows for the simultaneous testing of material properties along all axis, with anisotropy of the material resulting in an elliptical bulge. As a result, each test provides significantly more information than a single uniaxial tensile test would – an advantage when test material is difficult to obtain.
- When tested uniaxially, skin suffers from preconditioning effects, and gives unreliable results. Additionally, Yang et al (2015) showed that the collagen fibres in skin re-align when under uniaxial tension, strengthening the skin and resulting in an over-estimate of *in vivo* mechanical properties.

This prototype device allows for the high strain rate bulge testing of biological membrane tissue, capturing both pressure and displacement history. This pressure and displacement history can then be used to infer material properties of the tissue through FEA optimisation software such as LS Dyna's LS Opt or similar. This research will be of use in the fields of medicine and protective gear design.

[1] Wen Yang et al. On the tear resistance of skin". In: Nature Communications (2015).
[2] Theresa Koys Tonge. Micro-Mechanical Approaches for the Hierarchical Modelling of Soft Biological Tissues". PhD. Johns Hopkins University, 2014.

ALEXANDER BLOM

My introduction to robotics began at Westerford High School where I formed part of a First Lego League team. From there I started my BSc. in Electro-Mechanical Engineering at UCT where my passion for problem solving and seeking knowledge grew, leaving no rock unturned. I have since become eager to tackle tough problems, making it a personal challenge to find the best solution.

By the end of my degree I knew I was a roboticist at heart and would not be content with employment. Rather I found an opportunity to delve into a novel field with the Rapid Acceleration and Manoeuvrability (RAM) Research Group by doing my MSc. in Eng. With this research group I was faced with problems that required novel solutions, quenching my desire for a challenge and furthering my knowledge. My personal goal is to finish my Master's and either find employment with a company on the cutting edge of technology or start my PhD at a university with a focus on robotics design.

Supervisor
Dr Amir Patel

Department
Electrical Engineering

Research Title
Investigation of a Bipedal Platform for Rapid Acceleration and Braking Manoeuvres

ABSTRACT

Existing legged robots are capable of high speeds yet they lack the manoeuvrability available to their biological counterparts. Transient motions are poorly understood and has been avoided by researchers due to the aperiodicity and complexity of the motion.

This research project's aim is to develop a bipedal robotic platform capable of performing rapid acceleration and braking manoeuvres. However, due to the lack of research on such motions for a biped there is no existing design approach to ensure the platform is suitable. The robot design is inherently linked to the desired robotic motion [4] where a complex relationship exists between the leg morphology and the spatio-temporal gait characteristics for rapid manoeuvres. Simple calculations can guide design for simple tasks such as hopping but it becomes near impossible for motions that are more complex.

Existing legged robotic platforms work around this by taking inspiration from nature for platform design. However, robotics and animals are fundamentally different. Thus, the morphology of an animal for a specific task may not be optimal for a similar bio-inspired robotic platform.

In this project a mathematical approach is taken, avoiding direct inspiration from nature, to find the optimal design for a bipedal platform and generate the required trajectories for such motion. With the improvements in computational power and the novel techniques developed by the RAM Research Group, optimal control is used to examine a biped performing transient motions given the constraints of an available actuator and optimising the mechanical parameters. Specifically, finding the nominal leg length (L_1+L_2) and gear ratio for the motor.

ABSTRACT

With a realistic linkage morphology chosen, the 5 bar parallel linkage (see Fig. 1), the optimisation problem is formulated. The model must sprint a set distance, constrained to start and stop in rest and the objective function minimises the sprint duration. The results gained provided unique motion trajectories for time optimal behaviour with models performing motions seen in a biped's biological counterpart (see Figure 2).

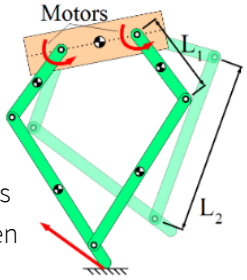

Figure 1: Biped Model

Surprisingly it is was found that access to a higher mass specific force (higher gear ratio) does not improve the rapid acceleration manoeuvres and the foot friction coefficient ends up as the limiting factor given sufficiently powerful actuators.

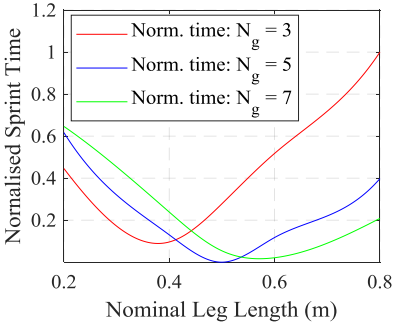

Figure 2: Sprint time against gear ratio and leg length

A parabolic relationship emerged for sprint time versus linkage lengths providing valuable insight into the parameters to use for the platform design (see Figure 3). Prior to this work, no research has focused on rapid acceleration manoeuvres of a biped in one optimisation problem.

The outcome of this project will be the manufacture and verify the platform for the results obtained.

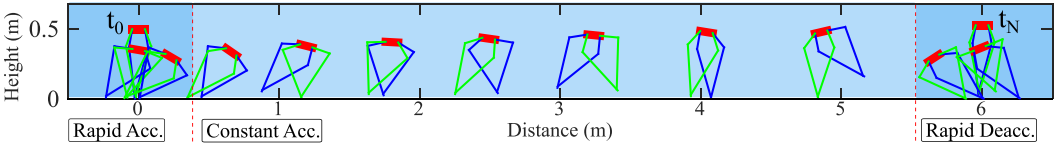

Figure 3: Optimal model sprint

ALIREZA MOGHAYEDI

I am a PhD candidate in the Construction Economics and Management. My research is focused mainly on modelling and simulation of construction of infrastructure projects.

"I enjoyed the sense of discovery and achievement…"

Before coming to UCT, I completed two postgraduate programs: Master of Science in Civil Engineering major in Transportation at the University of the Philippines and Master of Science in Construction Management at the University of the East.

Supervisor
Prof Abimbola Windapo

Department
Construction Economics and Management

Research Title
A Technique for Accurately Predicting the Impact Size of Uncertainty Events on Construction Time

ABSTRACT

This study examines the use of Stepwise Regression Analysis (SRA) and Adaptive Neuro-Fuzzy Inference System (ANFIS) in the prediction of the impact size of uncertainty events on construction time and whether one of the techniques is more accurate than the other.

The rational for the study stems from the availability of several techniques such as regression analysis and machine learning for developing predictive models of relationships of various variables in the construction industry. However, there has been limited research undertaken to compare the accuracy of the available techniques. The success or failure of prediction depends on the credibility of the prediction method. In this study, the predicted impact size of 76 uncertain events on the construction time of highway projects using Stepwise Regression Analysis (SRA) as a classical statistical method and Adaptive Neuro-Fuzzy Inference System (ANFIS) as an intelligence method were compared to delineate the ability and accuracy of two the prediction techniques.

The comparison of calculated R-Value and four error tests for SRA and ANFIS show that the constructed ANFIS model has a higher performance than the SRA method in both fitness and reliability of the prediction model. Also, the performance comparison showed that ANFIS is a good tool for predicting the impact of uncertainty events on construction project time.

Based on these finding, the study concludes that the use of intelligent methods such as ANFIS will minimize the potential inconsistency of correlations in construction time prediction.

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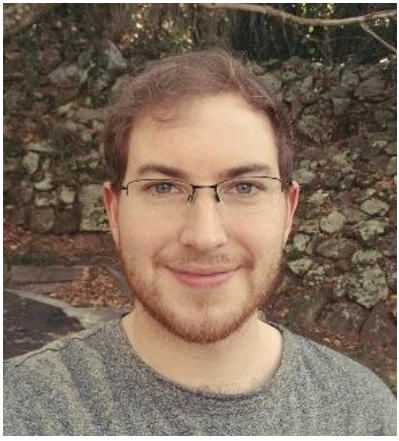
ANDREW CURRY



I am an enthusiastic and hardworking individual currently in the second year of my MSc (Eng) in Mechanical Engineering at UCT. I matriculated from Rondebosch Boys' High School in 2012 after which I enrolled in Mechanical Engineering at UCT. Throughout my degree I was exposed to many of the research projects that were taking place at the Blast Impact and Survivability Research Unit including completing my final year project at BISRU which peaked my interest in research.

After completing my undergraduate degree I still felt that I had more to learn at a university level so starting an MSc was the clear choice for me. Post-Grad was also an opportunity to hone the skills I had learnt in undergrad on a project that combined many of my interests. After completing my MSc I plan to enter the commercial-working world as a design engineer working to solve unique problems and build my own experience.

Supervisors
Dr Reuben Govender & Prof Gerald Nurick

Department
Mechanical Engineering

Research Title
Design and build of a low pressure bulge tester for quasistatic testing of skin and membrane tissue

ABSTRACT

The material properties of skin are of great importance to a variety of fields such as dermatology and cosmetic reconstructive surgery. Relatively little infrastructure and expertise exists locally in South Africa for testing biological tissue. The difficulty of testing the material properties of skin is the non-uniformity and anisotropy across specimen location and subjects. This anisotropy may be measured by tensile testing of samples cut in different orientations. However, the individual samples at different orientations would be extracted from slightly different locations on the same subject. This introduces a degree of uncertainty as the tissue properties at different locations may vary slightly, even within the same subject. This uncertainty may be avoided by applying biaxial tension to a specimen.

Bulge testing is a popular method of applying biaxial tension to a circular specimen. It uses a positive pressure applied to a peripherally clamped specimen to deform the specimen in a balloon type manner. This method of testing has been previously used by Tonge et al [1] for testing human skin.

This study aims to gain better understanding on the properties of skin at low strains and strain rates by the use of a bulge tester to load specimens in biaxial tension. The current scope is limited to in vitro testing and focuses on the initial loading phase as an initial step in a broader program.

This project seeks to expand on South Africa's expertise and infrastructure on this topic of research. The successful completion of this project will provide access to additional experimental testing equipment for local clinical researchers.

ABSTRACT

The methods of testing are currently limited to pressurisation rate and inflation rate control using a UV laser displacement sensor. Specimen deformation will be mapped using Digital Image Correlation (DIC) to achieve a full field strain map. The bulge testing device consists of syringe pump and inflation chamber as seen in Figure 1. Currently the mechanical device has been designed and built and the instrumentation and control system is under development.

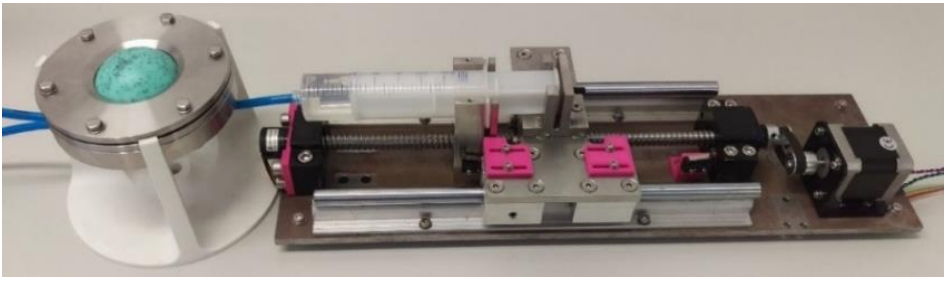


Figure 1: Bulge testing device showing the syringe pump (right) and inflation chamber (left).

[1] Theresa K. Tonge, Lorre S. Atlan, Liming M. Voo, Thao D. Nguyen, Full-field bulge test for planar anisotropic tissues: Part I – Experimental methods applied to human skin tissue, Acta Biomaterialia, Volume 9, Issue 4, April 2013, Pages 5913-5925.

AVELA KUNENE

I am currently undertaking a PhD degree at the University of Cape Town under the auspices of Catalysis Institute, within the Department of Chemical Engineering.

I was involved in various leadership roles…

I obtained MSc (Chemical Engineering) degree from the University of Cape Town in 2014. My current research interest involves investigating the effects of various parameters on oxidation of organic substrates over platinum-based catalysts.

During my time at UCT, I was involved in various leadership roles which include 2016/17 EBE Student Council as a Transformation representative.

Supervisor
Prof Eric van Steen

Department
Chemical Engineering

Research Title
The effect of water and support material on benzyl alcohol oxidation over platinum based catalysts

ABSTRACT

Transformation of benzyl alcohol through oxidation results in the formation of high-value oxygenated organic compounds such as aldehyde, ketones, dicarbonyls, which may be used as intermediates in e.g. pharmaceutical industry. The higher oxygen content in these high-value products renders them more sensitive to oxidation, thus requiring milder conditions in selective oxidation processes with sufficient activity.

It has been shown that the rate of oxidation of 1-octanol and 2-octanol is strongly enhanced by increasing the water content in the reaction mixture [1], despite the increased competitive adsorption [2]. Addition of water as a solvent for alcohol oxidation may enable an improved alcohol conversion to aldehyde products, in a selective manner. Moreover, it has been shown that the different support exhibit different catalytic performance [3]. This would eliminate various steps involved in the synthesis of these high-value chemical intermediates.

In this study, the effect of support material and water on benzyl alcohol oxidation has been investigated over Platinum based catalysts at 90 °C and 5 bar in a semi-batch reactor using continuous flow of air. Platinum is immobilized on various supports materials. The ratio of benzyl alcohol to water in the initial reaction mixture was varied keeping the total initial liquid volume constant.

Figure 1a shows the catalytic activity of platinum on various support materials prepared through slurry impregnation of TiO_2 with platinic acid depicting an average crystallite size of 1.96nm. Figure 1b shows the obtained activity as a function of time for mixtures with different amounts of water at the start of the reaction.

ABSTRACT

The catalyst activity increases with increasing amount of water in the feed mixture. Carbonyl products derived from the oxidation of benzyl alcohol are obtained via hydrogen abstraction from the aromatic ring [3]. In the case where water is present, the proposed mechanism for oxidation reaction of alcohols to form aldehydes is thought to occur via elimination reaction (E2) mechanism over a platinum or palladium catalyst [4].

The poster will exhibit the role of hydroxyl groups on the surface of the support and the role of hydroxyl species adsorbed on platinum in facilitating the oxidation of benzyl alcohol in the presence of water.

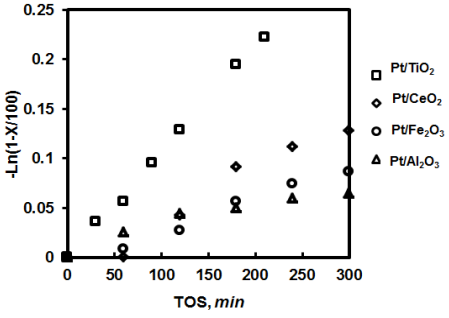


Figure 1a: The activity of platinum based catalysts immobilized on various support material

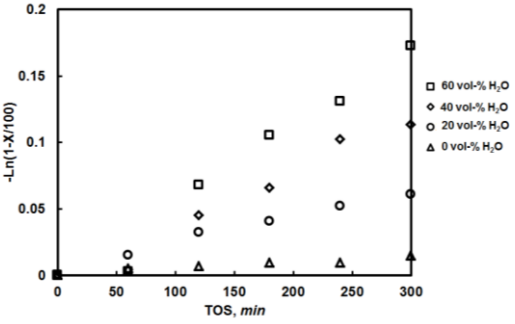


Figure 1b: Comparison of benzyl alcohol conversion at different water/substrate ratios over 4wt.-%Pt/TiO2 using air as an oxidant

[1] Frassoldati, A., Pinel, C. and Besson, M., Catal. Today, 2011, 173, 81-88.

[2] Tatsumi, H., Kiu, F., Han, H.-L., Carl, L.M., Sapi, A. and Somorjai, G.A., J. Phys. Chem. C, 2017, 121, 7365-7371.

[3] Wang, L. ChemPhysChem, 2015, 16, 1542–1550.

[4] Kluytmans, J., Markusse, A. and Kuster, B.. Catal. Today, 2000, 57, 143–15

CAROL ZETHU NGWENYA

I am from the Mpumalanga province and graduated with a National Diploma in Biotechnology at the Cape Peninsula University of Technology (CPUT).

I went on to complete a B. Tech in Biomedical Technology, followed by a M. Tech in Environmental Health, also from CPUT. The multidisciplinary M. Tech integrated the field of nanotechnology and biotechnology to address detrimental environmental concerns. I am currently strategically registered for an MSc (Eng) in Chemical engineering at UCT, after which I hope to embark upon obtaining a PhD, especially now with South Africa slowly moving towards the development of a bio-based economy where biotechnology contributes to a significant share of economic output. I hope to be part of the generation that will pioneer and lead the development of a sustainable bio-based economy.

Supervisors
Dr M. Smart & Prof Sue Harrison

Department
Chemical Engineering

Research Title
Waste to energy: Confectionery waste as a substrate for renewable energy production

ABSTRACT

The confectionery industry in South Africa has shown rapid growth and the sugar-rich waste generated by the industry is currently discarded into landfills. Landfilling is undesirable as it is a major environmental burden in South Africa. This project is aimed at investigating the feasibility of confectionery waste as a suitable feedstock for renewable energy production. Three approaches to bioenergy production will be investigated: 1) Bioethanol production using Zymomonas mobilis; 2) Biobutanol production by Clostridium saccharobutylicum and 3) Biogas rich in either methane (CH4) or hydrogen (H2) generated by a consortium of anaerobic microorganisms.

Research to date has been focused on bioethanol production using Z. mobilis ATCC 31821. Z. mobilis was cultivated anaerobically in medium containing confectionery or synthetic sugar mixes to simulate products such as hard candy, chocolate or marshmallows as carbon (C) source supplemented with essential nutrients. Z. mobilis cell biomass concentration, sugar utilisation rate and efficiency and bioethanol production was measured for each confectionery product used as C source. Characterisation of confectionery waste streams indicated that these predominantly contained a mixture of sucrose (60 %), glucose (20%) and fructose (20%). Z. mobilis was able to ferment the sugars in confectionery waste and produce ethanol. However, low ethanol concentrations were reported in all three waste streams due possible inhibition stemming from presence of unknown additives in confectionery products such as acidifiers, acidulants and colourants. To improve ethanol production from confectionery waste, Z. mobilis will be cultured in the new Brunswick bioreactor under modified environmental conditions such as pH and temperature for efficient sugar utilisation and bioethanol production.

Energy generation from waste streams is a sustainable approach for energy recycling during food manufacturing. These bio-based energy sources can be used to supplement the processing plant's energy requirements. This study aims to provide an overall comparison of the proposed energy routes using experimental data and techno-economic analyses of the process technologies and products.

CHARLOTTE WESSELS

I grew up in Tzaneen and attended Ben Vorster High School, thereafter I completed my undergraduate degree in Chemical Engineering at the University of Pretoria with the help of a Sasol bursary. I started working at Sasol in 2009 at the Polymers plant in Sasolburg. In 2014, I decided to return to the academic world and completed my honours and Masters in Water Utilization at the University of Pretoria. Upon completion of my Masters degree in 2016 an opportunity arose for me to take on a PhD at the University of Cape Town.

The reason for staying on in research was that I need to be challenged daily and to apply creativity in my work. I also care for the environment and love the challenge of a biological process, making it easy for me to work hard on my current project. My passions lie in finding novel solutions for problems faced by Industry.

Supervisor
Prof Sue Harrison

Department
Chemical Engineering

Research Title
Process Development for Lactic Acid Production from Pulp and Paper Wastewater

ABSTRACT

This project forms part of a larger project funded by the WRC that revolves around the design of a wastewater biorefinery (WWBR) suited to the pulp and paper industry. The aim of a WWBR can be summed up as maximizing resource productivity whilst lowering environmental impact without increasing economic burden. In the pulp and paper industry, the WWBR concept has potential to translate into the valorisation of the organics in the wastewater for bio commodity production, whilst raising the quality of the effluent to 'fit for purpose' water, for reuse within the mill or release to other uses or to the environment.

The pulp and paper industry is a good candidate for the valorisation of wastewater since it makes up a large part of our agricultural sector and is a water-intensive industry that produces large amounts of wastewater with a high organic loading. Due to this, the wastewater from pulp and paper mills harbour great potential for increased resource productivity and waste valorisation. A reduction in the industry's water footprint will also go a long way in improving its sustainability.

The review of potential products, focussing on platform chemicals in this project, has led to the proposal of lactic acid as the primary product in the proposed WWBR. Lactic acid is a platform chemical used in several industries, the major ones being the food, pharmaceutical, health care and chemical industries [1]. A large part of the lactic acid produced is used to make polylactic acid (PLA), a biodegradable plastic with high tensile strength used in the packaging industry [2].

In lactic acid production, deashing to allow for better solids handling, pre-treatment to liberate the organic carbon, and continuous simultaneous saccharification and fermentation operated with high cell densities to promote economic feasibility will form the heart of the project. In addition, the integration of the lactic acid process into the WWBR for integrated resource efficiency is central.

ABSTRACT

The aim of this project is to develop a process flowsheet for lactic acid production from pulp and paper mill wastewater, this will include selecting the most viable option for each step, starting with ash removal, followed by pre-treatment, enzymatic hydrolysis, fermentation and product purification. There are several ways in which this process can be configured, the challenge therefore will be in determining which is the most suited to the bigger picture of a WWBR.

[1] A. G. Daful, K. Haigh, P. Vaskan, and J. F. Gorgens, "Environmental impact assessment of lignocellulosic lactic acid production: Integrated with existing sugar mills," Food Bioprod. Process., vol. 99, pp. 58–70, 2016.

[2] S. S. Bapat, C. P. Aichele, and K. A. High, "Development of a sustainable process for the production of polymer grade lactic acid," Sustain. Chem. Process., vol. 2, no. 3, 2014.

CHELSEA TUCKER

I am currently completing a PhD at the Catalysis Institute, Department of Chemical Engineering at the University of Cape Town.

"I have a passion for design…"

My research falls within the petrochemical sector and focuses on developing a small-scale waste-to-fuel plant.

I have a passion for design and hope to work on greenfield energy projects in Africa after graduation.

When I am not working, I am an avid food and wine enthusiast who is always searching for the next best place to eat!

Supervisor
Prof Eric van Steen

Department
Chemical Engineering

Research Title
Biomass to Fuel: Studying the effects of high conversions on PtCo/Al2O3 for small-scale Fischer-Tropsch biomass-to-liquid plants

ABSTRACT

Since the 2015 Paris climate accord there has been a global drive searching for carbon-neutral fuels produced from renewable sources. The Fischer-Tropsch process is a well-established method that can convert carbon matter into diesel, petrol and jet fuel [1]. In the past, Fischer-Tropsch fuels were produced from coal (CTL) and natural gas (GTL) rather than biomass (BTL) or waste. Whilst the BTL-process is reported to be roughly carbon neutral [2], there are significant challenges associated with biomass as a feedstock. Not only is sustainably produced biomass costly, but the BTL facilities are limited by the amount of biomass that can be collected in a specific area [2]. In this way, small-scale plants are attractive option. However, FT plants are capital intensive [3] and small-scale operations will be limited by economies of scale. The economic viability of small-scale, biomass-to-liquid plants thus relies on design improvements that promote simplicity and cost effectiveness.

Removing the air separation plant, which costs up to 17% of the entire process, and thus operating the system in a simple once-through Fischer-Tropsch reactor configuration could be a practical way to make the process simpler and cheaper (Figure 1). However, this requires a high Fischer-Tropsch conversion per pass with operation at a high partial pressure of H2O and low partial pressures of CO and H2.

This study reports on the effects of these unusual conditions of high conversion on $PtCo/Al_2O_3$ in a slurry bed reactor at T=220°C, P=20 bara, with a feed from a simulated air-blown gasification (N_2:H_2:CO = 3:2:1). Increasing CO conversion was found to have negligible effect on CO_2 selectivity up to 70% conversion, after which a strong increase in the CO_2-selectivity (to >20%) was observed. This could be due to the water-gas shift reaction or re-reduction of CoO.

ABSTRACT

This increase in CO_2 selectivity created an imbalance in H_2/CO reactor ratio which resulted in a large increase in the methane selectivity from 12% to 45% over a 20% conversion interval. This was further accompanied by a decrease in chain growth probability, C_4 olefin/paraffin ratio and C_{5+} selectivity whilst slightly increasing C_2-C_4 selectivity.

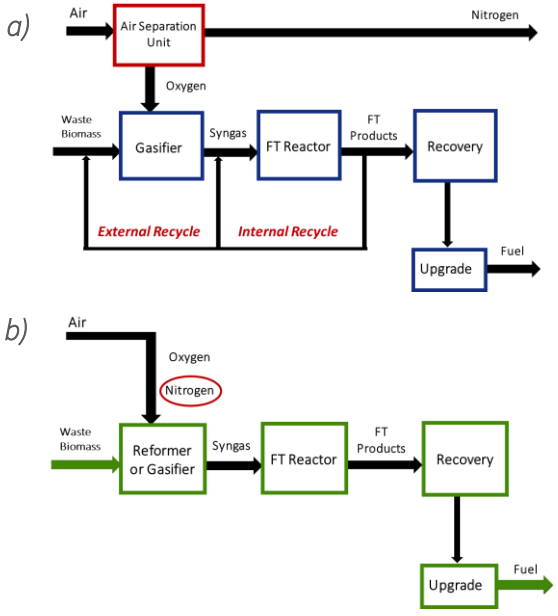


Figure 1: A Fischer-Tropsch biomass-to fuel plant a) with and b) without an air separation unit

[1] M. E. Dry, "High quality diesel via Fischer-Tropsch process - a review," J. Chem. Technol. Biotechnol., vol. 772001.

[2] G. Liu, E. D. Larson, R. H. Williams, T. G. Kreutz, and X. Guo, "Making Fischer–Tropsch Fuels and Electricity from Coal and Biomass: Performance and Cost Analysis," Energy & Fuels, vol. 25, no. 1, pp. 415–437, 2011.

[3] R. Zennaro, "Fischer – Tropsch Process Economics," Greener Fischer-Tropsch Process., pp. 149–169, 2013.

CHRIS KOTZE

I am currently undertaking a MPhil in Space Science at the UCT. My other qualifications include a BCom Honours in IS (UCT), BSc in Human Physiology & Microbiology (UP), Diploma in Datametrics (Comp. Sci) from UNISA and various executive courses at UCT Graduate School of Business. ISACA Certified in the Governance of Enterprise IT (CGEIT), TOGAF 9 Certified (Enterprise Architecture). I am a firm believer in "ICT4SDG" – using Information & Communication Technology to support sustainable development.

A key for successful sustainable development is levelling of the playing field. There exists a massive opportunity to unlock the tremendous Human Capital currently prevented from partaking in the emerging "Industry 4.0" by bridging the digital divide. As a technology strategist I have a special interest in demonstrating how technology can be used to advance the Quadruple Bottom Line (People Profit, Planet & Purpose) and the benefits thereof.

Supervisor
Prof Peter Martinez

Department
Electrical Engineering

Research Title
Connect A Village: From "Not-Spot" to "Hot-Spot"- A broadband appliance for underserviced remote communities

ABSTRACT

Access to broadband internet is the key to participate in the developing "Fourth Industrial Revolution", with those on the wrong side of the digital divide automatically excluded. The purpose of this study was to investigate how broadband can be delivered to infrastructure lacking remote communities through the use of satellite and other enabling technologies in the form of a "Self-contained Hot-Spot Appliance". How such a device could help bridge the digital divide, contribute economically through the "broadband ecosystem", support development initiatives and how such a system could be funded potentially. Figure 1 is a high level representation of the research.

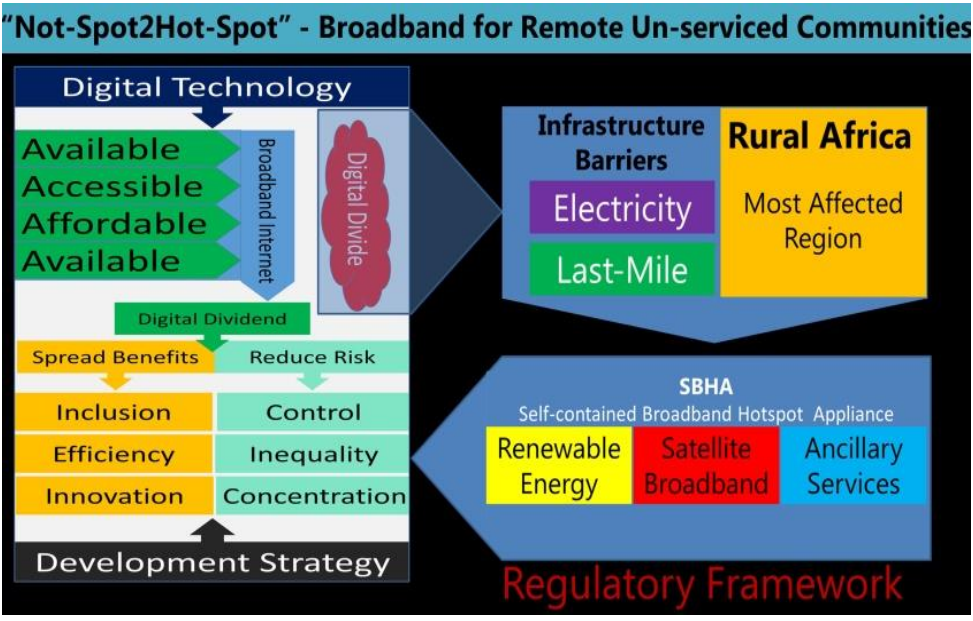


Figure 1: Representation of research

CHRISTA NSANZUBUHORO

I completed my primary and secondary schooling in Swaziland. Thereafter, I pursued my undergraduate degree in Mechanical Engineering at UCT and am currently pursuing a MSc in Mechanical Engineering specialising in Energy and Heat Transfer. The decision to undertake a postgraduate degree emanates from my interest in expanding my understanding and knowledge in the field of energy. Research proved to be a good opportunity to achieve this.

Through conversations with various friends and colleagues with experiences in industry, I have come to realise the important role that a postgraduate qualification plays in industry success. One of my major goals is to obtain a PhD in my field and through my research, effect socio-economic advancement in Africa. And finally, very important to me as well is the matter of gender representation within my department. One of my personal goals is to inspire other young women to conquer the postgraduate mountain in traditionally male-dominated fields.

Supervisors
Prof Tunde-Bello Ochende & Prof Arnaud Malan

Department
Mechanical Engineering

Research Title
Thermodynamic Optimisation of Feedwater Heaters in a Fossil Geothermal Hybrid Power Plant

ABSTRACT

Sufficient energy supply is a fundamental necessity to stimulate socio-economic advancement. However, the current rapid rise in urban population has resulted in energy demand increasing significantly. Consequently, the conventional energy supply systems are facing numerous challenges in meeting the increasing demand sustainably. Considering this, it is important to pioneer innovative ways to integrate sustainable renewable energy solutions into the already existing systems or better yet create new systems that all together make use of renewable energy.

This research aims to establish the optimum working parameters of an existing fossil fuelled power plant. The power plant makes use of renewable energy (geothermal energy) to achieve the primary objective of increasing efficiency in an environmentally sustainable way. In a broader sense, this research emphasises the impact renewable energy has on major power plant systems that are in operation and run on non-renewables. For this purpose, a simplified model of a geothermal preheat hybrid system, depicted in Figure 1, is designed for analysis.

Engineering Equations Solver (EES) is used to perform a thermodynamic analysis of the system. Thereafter, the method of Number of Entropy Generation Units, developed by Adrian Bejan [1] is employed to optimise the designed system.

Given that the boiler is a more complex system to optimise, the feedwater heaters are selected to undergo optimisation. The thermodynamic analysis reveals that relative to the rest of the system, entropy generation is highest in the boiler first and then the feedwater heaters. These (feedwater heaters) are modelled as counter-flow heat exchangers. Once they are optimised, the operating conditions of the boiler and turbines are secondarily improved.

ABSTRACT

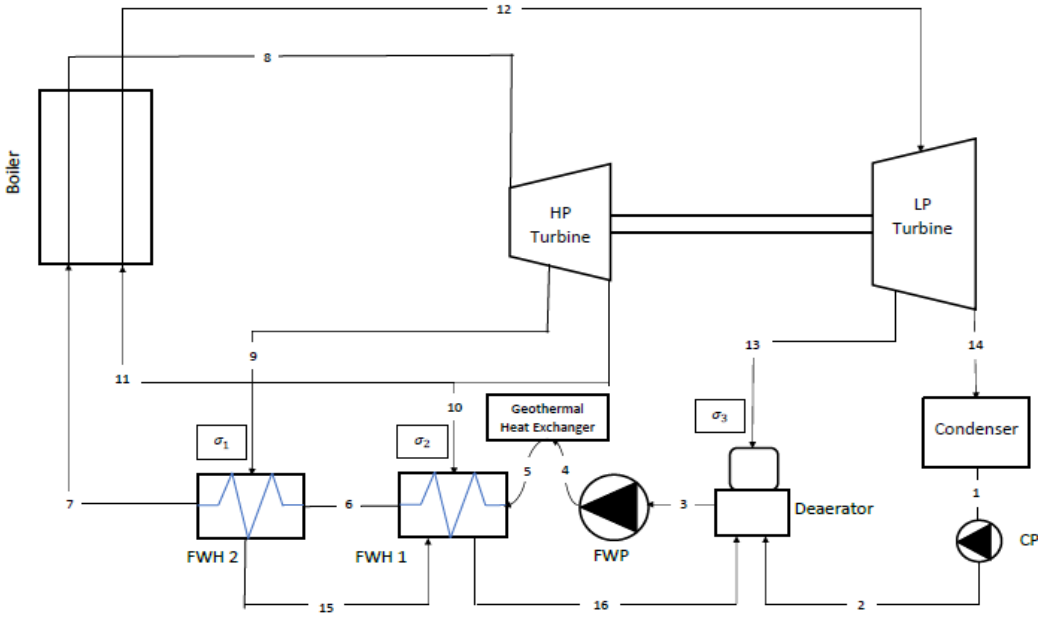


Figure 1: Geothermal Preheat Hybrid Power Plant

[1] A. Bejan, "The Concept of Irreversibility in Heat Exchanger Design: Counter Flow Heat Exchangers for Gas-to-Gas Applications," Journal of Heat Transfer, vol. 99, pp. 374-380, 1977

CHRISTIAN POLORIGNI

I hail from Togo and am doing my MSc in Civil Engineering, specialising in Water Quality Engineering and expecting to finish in 2018. I completed my BSc Civil Engineering with Honours in 2016, also at UCT.

I discovered wastewater engineering in my final year of undergraduate degree with newfound fascination. I realised that there is a huge potential for treating wastewater since water and nutrients such as phosphorus and nitrogen (which are getting increasingly scarce) can be recovered into other by-products (fertilisers). Furthermore, the prospect of retrieving energy through methane production from anaerobic digestion of sludge, made me want to know more about these processes and hence I decided to go into research. Because I can see wastewater from the lenses of resource recovery, I want to become an expert in that field and get involved in the generation of low cost energy (biogas) as well as affordable soil conditioners to our populations that are mostly dependent on agriculture.

Supervisor
Dr David Ikumi

Department
Civil Engineering

Research Title
Towards the development of a realistic primary settling tank model with characterized settling velocity groups

ABSTRACT

Most of the current PST (primary settling tank) models are unable to link the measured influent data (inputs) with the primary sludge and the settled wastewater (outputs) and therefore make assumptions or use empirical relations, which may lead to poor predictions on energy recovery from the treatment processes system. The inaccuracies, when tracking the energy plant-wide, occur when the settleable portion (primary sludge) of the total suspended solids (TSS) is incorrectly proportioned according to its biodegradable particulate organics (BPO), unbiodegradable particulate organics (UPO) and inorganic suspended solids (ISS) components.

The purpose of this investigation is to propose the development of a realistic primary settling tank model that improves on a current TSS-based PST model (Bachis et al., 2015), to account for correct proportions of BPO, UPO and ISS.

The methodology involved both experimental studies and modelling. The modelling component generally requires (i) using the particle settling velocity distribution (PSVD) theory (Bachis et al., 2015) to extract the TSS into different proportions of the abovementioned constituents, and (ii) calibration of the improved model to observe (a) strict material mass and charge continuity, (b) data reproducibility as well as (c) anaerobic sludge and settled wastewater predictions. The experimental study consisted on generating data from (i) a settleometer fed real raw sewage, and (ii) a full primary settling tank from a wastewater treatment system. These data generated were used towards the model calibration and validation respectively.

It is expected that the improved model predicts into correct proportions (Wentzel et al., 2006; Ikumi et al., 2014) the BPO, UPO and ISS components of the primary sludge. Hence, the characterized primary sludge which is an anaerobic digester (AD) input can become a prediction tool with regards to the AD's correct behaviour through products such as methane, nutrients, weak acid/base conditions and pH, which are critical to predict the potential for failure or system recovery.

ABSTRACT

Since primary sedimentation is the initial stage in a wastewater treatment plant and its outputs feed into the other unit processes, the study expects to accurately predict the energy line between these different units by characterizing the primary sludge into BPO, UPO and ISS. Such a primary settling tank model could be realistically integrated to the other unit process models, such that waste resource recovery options could be mimicked more accurately.

CLAIRE LAWRENCE

I graduated from Kimberley Girls' High School in 2012 and went on to study Mechanical Engineering at the University of Cape Town in 2013.

"I have always fostered a love for research…"

I have always fostered a love for research and was an avid participant in the ESKOM Expo for Young Scientists in high school, therefore it seemed natural that I pursue my Master's degree after graduation.

I hope to complete my MSc in Mechanical Engineering by the end of this year and go on to find a job which interests and challenges me as much as research has.

Supervisors
Mr Trevor Cloete & Prof Gerald Nurick

Department
Mechanical Engineering

Research Title
Macroscopic properties of microlattices and trabecular bone models

ABSTRACT

A comprehensive, yet efficient method of determining the macroscopic properties of trabecular bone has long been sought after for applications in biomedical implants as well as the prediction and treatment of osteoporosis. A number of methods have been suggested in the past, however none of them seem to yield the optimal combination of accuracy coupled with efficiency. To be able to accurately predict the macroscopic properties of bone, a model must be developed which allows for a patient's specific bone structure to be considered, as bone structure varies between individuals and anatomic sites [1].

The aims of this project are to develop a system to numerically determine the macroscopic modulus of a trabecular bone specimen, given micro-CT scans of the microstructure, and to analyse the accuracy and validity of the developed system.

The methods used to meet the aims are threefold. Firstly, to develop a code which binarises and crops the input micro-CT scans, discretises the structure into a series of plates and rods, writes the required input decks for Finite Element Analysis (FEA), performs a linear, quasistatic simulation on the structure, calculates the macroscopic modulus of the structure and reconstructs the structure using the node and element data used in the FEA. Secondly, to run cubic, octet-truss and kelvin cell lattices through the generated analysis cycle and compare the simulated results to the theoretical values, focussing particularly on mesh discretisation and macroscopic modulus will be run. Thirdly, to Run micro-CT scans of bovine bone through the analysis cycle and compare the simulated modulus to the modulus obtained during experimental testing of the bone specimens.

Code was obtained from Prof. Harry van Lenthe at KU Leuven, which allows a given specimen to be discretised into plates and rods for FEA. This code was incorporated into the developed system which performs the full analysis cycle on a specimen and outputs the macroscopic modulus and reconstructed image between 5-90 minutes later, depending on the size and complexity of the structure.

ABSTRACT

This cycle takes micro-CT scans (in the form of a .tif stack) as its input, which allows the particular structure of the specimen to be considered.

Currently, testing of the analysis cycle is underway. When cubic lattices of varying sizes are run through the analysis cycle, the discretisation of the structures correlates well with what is expected from the theory, yielding a maximum average error of 10%. The simulated modulus also correlates well with theory, producing an average error of 8.5% when compared to theoretical values.

[1] J.-Y. Rho, L. Kuhn-Spearing and P.Zioupos, “Mechanical properties and the hierarchical structure of bone,” Medical Engineering & Physics, vol. 20, pp. 92-102, 1998.

DOMINIC DE OLIVEIRA

I am a Master's student in Chemical Engineering at UCT. I was accepted to study chemical engineering at UCT in 2012 and graduated in 2015. Since then, I have been studying toward a MSc in Chemical Engineering, specifically in the field of catalysis as part of the Catalysis Institute and c*change (DST-NRF Centre of Excellence in Catalysis).

Part of my motivation for going into research was the realisation that, upon the completion of my undergraduate studies, my learning journey was incomplete.

Pursuing a Master's degree allows me to further my learning in an environment dedicated to education, as well as to contribute meaningful research to our group at UCT and have some small impact in the field of science.

Supervisors
Dr Nico Fischer & Prof Michael Claeys

Department
Chemical Engineering

Research Title
Phase and structural changes of nickel catalysts as a function of reaction conditions

ABSTRACT

Carbon dioxide hydrogenation is a catalytic process used in the production of methane and in the purification of CO_2 containing feedstocks. Research into CO_2 methanation has attracted recent attention in today's global climate, due to the increasing importance of reducing CO_2 emissions [1,2]. Nickel catalysts are the most widely used for steam reforming and methanation reactions due to their low cost, high activity and high selectivity towards methane [1].

Studies have been carried out on the size and structure sensitivity of the methanation reaction [3,4], however this research is focussed mainly on CO methanation, with minimal research conducted on the size effects in CO_2 hydrogenation. To investigate the crystallite size effects of the reaction, a model catalyst system with narrow crystallite size distribution is required. The preparation of these model catalysts has been carried out by supporting synthesized nickel nanoparticles, with tuneable and narrow size distributions, on silica spheres. The loaded silica spheres were then coated with a porous silica over layer to minimise the effects of sintering, preventing changes to the nanoparticle size.

Catalysts with varying nickel crystallite size have been tested, in the range of 5 – 40 nm. The testing of these catalysts was conducted at 20 bar, 250 °C and H_2:CO_2 ratio of 4:1, using the in-situ magnetometer at UCT [5]. The use of the magnetometer enables the determination of the particle size during the testing, i.e. under reaction conditions, through the magnetic measurements taken. Size analysis was carried out on fresh and used catalysts with transmission electron microscopy (TEM) and was compared to the results derived from the magnetic measurements.

[1] S. Rönsch, J. Schneider, S. Matthischke, M. Schlüter, M. Götz, J. Lefebvre, P. Prabhakaran, S. Bajohr, Fuel 166 (2016) 276-296.
[2] G. Iglesias, C. de Vries, M. Claeys, G. Schaub, Catal. Today 242 (2015) 184-188.
[3] J. Vannice, Catal. 46(1) (1976) 152-162.
[4] J. Rostrup-Nielsen, K. Pedersen, J. Sehested, Appl. Catal. A: Gen. 330 (2007) 134-138.
[5] M. Claeys, E. van Steen, J. Visagie, J. van de Loosdrecht, A Magnetometer, WO2010/004419 A2, University of Cape Town, 2010.

DONALD MJONONO

I began my MSc in Chemical Engineering in March 2017, under the supervision of Dr. Thanos Kotsiopoulos and Prof. Sue Harrison. After completing my BSc in Chemical Engineering at the National University of Science and Technology, I worked as a research assistant in the research and development department at Unilever in Zimbabwe. Seeking to apply and expand his environmental knowledge to a more specific object of study he was motived to join the Acid Rock Drainage mitigation group at the Centre for Bioprocessing Engineering Research at the University of Cape Town. My current research interests are focused on the sustainable utilisation of natural resources and conservation of freshwater resources in Africa. As a result, I intend to develop a demand integrated water resources planning and management system. I am a visual artist and he enjoys biking, debate and public speaking.

Supervisors
Prof Sue Harrison & Dr A. Kotsiopoulos

Department
Chemical Engineering

Research Title
Application of geotechnical protocols in mine waste packing strategies to enhance acid rock drainage prevention

ABSTRACT

In the prevention of acid rock drainage (ARD), co-disposal of waste rock and fine-grained benign wastes presents an opportunity to restrict the exposure of sulfide minerals to the oxidizing agents. In the presence of water and oxygen, the sulfides undergo oxidation to form acidic solutions. Iron and sulfur oxidising microorganisms further intensify this oxidation process leading to the rapid generation of ARD.

To prevent the pollution of the environment, mine waste packing protocols have been developed at lab scale. In these protocols, the complementary physical and chemical properties of the mine waste aggregates is exploited. Waste rock aggregates enhance the strength and stability of packed beds. However, these packed beds may lose structural integrity with the continual exposure of the sulfide rock surfaces to the free-flowing aqueous oxidants.

Addition of fine-grained benign aggregates in such packed beds offers multiple benefits. Fine-grained benign particles neutralise acidity and restrict the flow of oxidants. Further, these fine benign components create a barrier that envelopes the coarse-grained particles to reduce the exposure of the sulfide mineral surfaces to oxidative environments.

The success of this co-disposal approach, however, is contingent on the neutralising capacity of the fine benign fractions, the exposed surface and the degree of packing of the co-mingled wastes. The latter is shown to be a significant contributor to the successful long-term mitigation of ARD once associated neutralisation of the desulfurised fines are exhausted [1].

ABSTRACT

In this study, packing protocols are developed to aid the prevention of ARD. Various packing techniques are investigated to improve and sustain the structural integrity of ore waste beds.

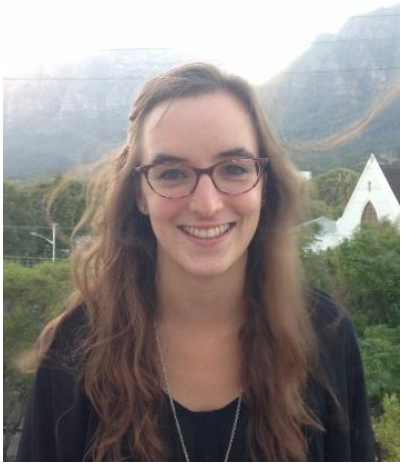
Dry mass ratios of 3:2 and 2:3 mixtures of coarse and fine fractions, respectively, are utilised in these studies. Contrasting packing techniques are explored to maximise the solid content in the packed beds and to reduce the volume of voids. Slump tests and packing density tests are used to evaluate the consistency of mixtures and the packing behaviour of the waste materials, respectively.

Compressibility tests are conducted to evaluate the structural integrity of the packed beds. It is revealed that at a wet packing density of 0.89, the void ratio is smaller, and the tendency for the packed bed to deform is low. Accordingly, the results from kinetic column tests indicate that dense deposits composed of blended waste rock and benign fine waste are associated with low leachate flow rates.

It is concluded that a correlation exists between high packing density, high bed mechanical strength and prolonged preservation of neutral conditions in the packed beds.

[1] Kotsiopoulos, A., Harrison, S.T.L., 2018. Co-disposal of benign desulfurised tailings with sulfidic waste rock to mitigate ARD generation: Influence of flow and contact surface. Miner. Eng. 116, 62–71.

GENEVIEVE HARDING



Upon finishing school, I was determined that I would change the world.

I have always been passionate about the environment, and specifically water (the foresight of my 18 year old self was on point, very topical at the moment!); and I thought a degree in chemical engineering would help channel my passion in a productive direction.

I completed my undergraduate degree in 2015, and have since been working toward my Master's degree with the Crystalization and Precipitation Unit at UCT. Furthering my studies has helped me specialise and refine my knowledge, and hopefully contribute to an important conversation around water in South Africa. My goals for the future are to take on my school girl dreams, qualify as a professional engineer, and indeed change the world!

Supervisors
Jemitias Chivavava & Prof Alison E Lewis

Department
Chemical Engineering

Research Title
Understanding and accessing industrial effluent water quality:
What is the norm and why we need to do better?

ABSTRACT

South Africa is a water stressed country, therefore it is important to understand water use and effluent generation. Previous research and workshops have identified gaps in the characterisation and remediation of effluents in South Africa [1]. Treatment is required to remediate effluents; while characterisation is required to develop treatments. Yet characterisation is often poorly reported for effluents. Effluents are characterised privately for company records and permits. But is effluent characterisation data accessible? How can it be accessed? And once accessed, what is reported?

Effluent characterisation data was acquired by 'unlocking' inaccessible public and private data through informal and formal routes. The former included building relationships with industry partners via telephone calls, emails and semi-structured interviews. This was often met with fear or reluctance. Formal approaches used legal applications through the Promotion of Access to Information Act.

Van der Merwe et al. [2] and Cloete et al. [3] identified pulp and paper, fish processing, power generation, mining and petroleum industries as major effluent generators by volume in South Africa. Their estimates of effluent volumes ranged from 70 – 350 Mm^3/annum. Seven parameters were commonly used for characterisation: pH, volume, electrical conductivity, nitrogen, sulphate, sodium and COD. Calcium was not measured, even though it was a listed parameter in environmental licenses. In terms of reporting norms, this research has revealed that composition information is often inadequate, incorrect and inconsistent in terms of meaningful parameters. Although effluent information is not confidential [4], in practice it is not readily available. This work has highlighted barriers with regard to accessing information, which requires resources including time and money.

ABSTRACT

There are opportunities to improve wastewater management and resource recovery, however this needs to happen in an environment of trust and transparency. Potential value can be recovered from waste streams and protect the environment. However, in order to achieve this, meaningful effluent characterisation is needed. Making this information available and accessible is crucial to push forward research on effluent remediation. This is important for relevant research, governance and industry.

[1] Claassen, M., W. Masangane. 2015. The Current State and Future Priorities of Brine Research in South Africa: Workshop Proceedings. Water Research Commission Brine Workshop, Pretoria, South Africa.

[2] van der Merwe, I. W., Lourens, A., Waygood, C. 2009. An Investigation of Innovative Approaches to Brine Handling, Water Research Commission, Report No. 1669/1/09.

[3] Cloete, T., Gerber, A., Maritz, L. 2010. A First Order Inventory of Water Use and Effluent Production by SA Industrial, Mining and Electricity Generation Sectors. Water Research Commission, Report No. 1547/1/10.

[4] National Environmental Management Act, No. 107 of 1998. 1998. Government gazette. 401 (19519). 27 November. Government notice no. 1540. Cape Town: Government Printer.

IOSIF JOS VAZIRGIANTZIKIS

I started my tertiary education at University of Stellenbosch, where I completed a BSc degree in chemistry and polymer sciences. I decided to then complete my honours degree in materials engineering at University of Cape Town as this gave me the opportunity to apply my knowledge of chemistry to real world engineering problems.

After completion of my honours I started a Master's program in Materials Engineering, which was later upgraded to a PhD. I decided to pursue research as a possible career path because I enjoy solving problems in creative ways. My goals at this moment in time are to successfully complete my PhD in 2018 and to obtain a post-doctoral position at a well-respected university or conduct industry related research.

Supervisor
Dr Sarah George

Department
Mechanical Engineering

Research Title
The effect of silver ion implantation on the surface morphology of polished and anodised titanium surfaces

ABSTRACT

Ti-6Al-4V is commonly used for the manufacture of orthopaedic implants. The primary aim of these devices is to provide stabilisation of fractures or replacement of joints themselves. These orthopaedic devices may function well, but acute and chronic infections are potential complications that may necessitate the removal of the titanium device or implant.

There are various techniques employed to minimise the infection rates, such as impregnation with antibiotics. Silver has long been known for its antimicrobial properties, and research is now turning to its use in orthopaedic implants. The titanium base material will need to have a certain surface roughness to create reservoirs for the ionic silver, so that these ions can be present when the device is implanted, and slowly released into the surrounding tissues.

The project aims to develop a scalable process for the surface modification of Ti-6Al-4V implants through the introduction of ionic silver onto the surface. The objectives will have two foci, namely, the surface preparation of the titanium material and the impregnation of the surface with ionic silver.

The final stages of this project will look at the effectiveness of the ionic silver on the surface and will focus on the micro-biological side of the project.

JAVON FARAO

I attended the Settlers High School in Bellville, Cape Town and matriculated in 2008. I attained a B.Sc (Eng) degree in Mechanical Engineering at UCT in 2012 with first-class honours. I was only able to study at UCT due to a scholarship from the Allan Gray Orbis Foundation.

My interest in flight mechanics and engineering was piqued as a high school scholar in the Young Falcons cadet programme of the South African Air Force. Whilst working on my final year undergraduate project with my current supervisor, Professor Arnaud Malan, an opportunity arose to pursue post-graduate studies in my field of interest: aeronautical engineering. I then joined the Industrial Computational Fluid Dynamics Research Group to commence a Master's degree. I completed my M.Sc (Eng) in 2015 titled 'Towards a full aircraft model for large passenger aircraft loads calculations with fuel slosh effects'. Due to the scope and novelty of the Master's, a PhD study was launched to extend the Master's framework.

Supervisors
Prof Arnaud Malan & Mr Francesco Gambioli

Department
Mechanical Engineering

Research Title
Advanced Loads Calculation Procedure for Large Passenger Aircraft

ABSTRACT

During the loads analysis procedure of large civil aircraft, accurate load prediction via a cost-effective method is of crucial importance. For the purpose of loads calculation, the Airbus System employs a Full Aircraft Model (FAM) comprising of reduced-order models (ROMs) to account for structural, aerodynamic and sloshing loads.

There is now an interest in using higher fidelity non-linear ROMs with an extended application range. This ought to facilitate marked improvements in accuracy over current linear models used for aircraft design while demanding minimal additional simulation time.

Currently, the structural component is typically modelled via a linear modal method applicable to beam elements. Due to an increase in composite materials being utilised in aircraft structures, the wing component is lighter and offers increased flexibility. This warrants development of an accurate, geometrically non-linear beam model. The beam is described via Timoshenko beam theory and the governing equations are discretized via the finite element method (FEM). Extension of the linear beam ROM model is enabled via a quadratic modal approach. The higher-order mode shapes, Gij, are calculated from the known linear mode shapes, φi, and incorporated into the transient analysis, as per Eq. (1).

$$\boldsymbol{U}(x,t) = \sum_{i} \phi_i \boldsymbol{q}_i + \sum_i \sum_j \phi_i \phi_j \boldsymbol{G}_{ij}$$

Equation (1)

ABSTRACT

The aerodynamic ROM aims to apply loads associated with the dynamic movement of air on the wing surface, at pre-determined locations along the wing. Aerodynamic gust load analysis is commonly performed in the frequency domain which is incongruent with the time-domain requirement of the FAM. Roger's method is thus employed to transform the frequency domain loads into the time domain, while retaining the non-linear aerodynamic phenomena.

There is further interest in accurate modelling of fuel sloshing loads induced by the fuel movement within the wing tanks. These dynamic loads, caused by operational excitations, vary significantly depending on excitation frequency, tank fill level and tank geometry. A computational fluid dynamics (CFD) tool, called Elemental TM, offers an accurate, high-fidelity solution albeit computationally costly. A pragmatic strategy is developed that combines the accuracy of the CFD tool with a conservative technique, thus modelling the slosh as a dynamic frozen fuel mass. In addition, the ROM is to account for tank pressure distributions which may be applied as moments and forces onto the structure.

The FAM is constructed by coupling the aerodynamic, structural and fuel slosh ROMs via a fluid-structure interaction (FSI) methodology. This procedure is enlisted to ensure that the computed from the FAM responses are numerically stable. In essence, the structural, aerodynamic and slosh models are forced to be in kinematic and dynamic agreement at every iteration in the solution procedure.

KERRY-ANNE AIREY

My research journey began by considering the problem of resharpening polycrystalline diamond tools, for the automotive industry for my BSc (Eng). This expanded during my MSc into researching diamond cutting tools through the creation of an accelerated wear testing protocol for PCD oil and gas cutting inserts.

My PhD centres me securely in the field of advanced manufacture, with a current focus on improving the manufacturing techniques associated with aerospace titanium in an effort to not only improve the efficiency of the manufacturing process, thus reducing cost, but also expanding the variety of titanium products.

On completion of my studies I intend to continue my research into advanced manufacturing techniques and look forward to my next evolution

Supervisor
A.Prof R. Kuppuswamy

Department
Mechanical Engineering

Research Title
Research endeavours on discrete machining for controlling the severe plastic deformation (SPD)on difficult-to-machine materials through the application of a new Modular Assisted Machining (MAM) system

ABSTRACT

The next generation of fuel-efficient aircraft is to employ significant tonnage of titanium alloys (20% by weight), focused in critical components to take advantage of titanium's superior strength-to-weight ratio of 260 – 300 kN.m/kg, high temperature performance of up to 400°C and corrosion resistance. Hindering this are the challenges of machining titanium - including cutting forces rising to 5 times higher than conventional material machining. Shear banding and sever plastic deformation indicate twice the plastic strain is generated, with consequentially high tool wear generation, shape errors of 2 µm and surface roughness values twice that of acceptable standards

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General trends in modulation-assisted machining (MAM) show marked improvements to cutting of titanium, with corresponding reductions to tool wear, cutting temperatures, machining forces and cycle times. Controlling the functional attributes of machined surfaces, regarding the microstructural and residual stress (surface integrity) changes, allows the simultaneous increasing removal rates and reducing tool wear.

Understanding the generation of severe plastic deformation (SPD) during titanium machining, allows the characterisation of complex deformation and microstructure. Experimentation, with in situ measurement of strain, strain rate and temperature, complements this characterisation, enabling model development and validation. Advanced finite element analysis predicts the severe plastic deformation (SPD) underlying machining, and generates phenomenological insights into microstructure evolution of SPD, thus providing a transformative bridge between scientific understanding and its efficient use in discrete products manufacturing. The application of this understanding to discrete machining of titanium alloys is expected to improve product quality and productivity across low-frequency modulation in machining (MAM).

KIMBERLY LIU

I am currently a 1st year Master Civil Engineering student under Future Water research institute and supervised by Prof Neil Armitage.

I chose to continue doing research in urban water field is because I want to explore further on my undergraduate thesis about how longer time frame changes the behaviour of permeable pavement system in treatment efficacy capabilities.

My personal goal is to assist in the development of a guideline on constructing the permeable pavement systems (PPS) in South African context with the help of my supervisor. Ultimately, I would like to help provide solutions to the existing water shortage problem in South Africa by determining the efficiency and effectiveness of PPS – one of the many Sustainable Drainage Systems (SUDs) practices.

Supervisor
Prof Neil Armitage

Department
Civil Engineering

Research Title
Using lab experiments to determine the treatment efficacy of permeable pavements

ABSTRACT

Rapid population growth, change in land use, stress on available resources and change in nature of stakeholders all form part of the urbanization process, which impose a significant impact on the availability of water [1] . Sustainable Drainage Systems (SuDS) offer an alternative approach to conventional drainage practice, which will help to reduce the surface runoff, threat of contamination and provide amenity and biodiversity to create attractive green public spaces.

Sustainable Drainage Systems (SuDS) offer an alternative approach to conventional drainage practice, which will help to reduce the surface runoff, threat of contamination and provide amenity and biodiversity to create attractive green public spaces. As one of the source controls to reduce the surface runoff, Permeable pavement systems (PPS) are able to provide a structural pavement for the public and road traffic whilst allowing water to filter through the gaps of the pavements.

Unlike conventional pavements, permeable pavements address both flooding and pollution issues, and can collect, treat and infiltrate surface runoff to support groundwater recharge.

This research aimed to test the treatment efficacy of permeable pavement in a controlled laboratory environment. Eight experimental cells housing different permeable pavement test structures, each with a drainage valve at the base were constructed in the laboratory. An infiltration test was first conducted to test the hydrologic performance of each of the PPS cells, followed by a 'clean water test' to establish 'base-line' pollutant values before the application of storm water pollutants, and lastly a simulated rainfall events which consist of synthetic storm water were carried out by adding the selected pollutants to each pavement surface to test the treatment efficacy of the permeable pavement systems.

ABSTRACT

It is anticipated that this research will contribute to the limited research on treatment efficacy of permeable pavement systems in South Africa context, therefore to provide an alternative way of storm water harvesting and reuse to solve the South Africa's water shortage problems.

Figure 1: PPS experimental cells

[1] Majumder, M. 2015. Impact of urbanization on water shortage in face of climatic aberrations. Agartala, India: National Institute of Technology Agartala. DOI: 10.1007/978-981-4560-73-3

KIRSTEN MONIQUE MOSES

I obtained my Bachelors of Architectural Studies at UCT in 2014 and thereafter worked at an architectural firm, KMH Architects, as a candidate architect before returning to complete my Honours in Architectural Studies.

In 2017 I worked again while doing independent research and participating in a research group focusing on ideas surrounding the notion of decolonising architecture (pedagogy) and architectural knowledge bodies. We interrogated questions of what an African architectural curriculum looks like and how its taught.

The research I am currently doing strongly aligns to the goal of transforming how we engage with architectural education and architecture for better performance of social and civic spaces in urban African cities.

Supervisors
Dr Fadly Isaacs & Dr Melinda Silverman

Department
Architecture, Planning & Geomatics

Research Title
Rethinking Civic Space in the Urban African Condition

ABSTRACT

This research and design inquiry focusses on the urban realities of civic spaces, its function and ways in which state and individual political agency manifest by contextualising it in the 'civic precinct' of Delft North, a neighbourhood in the Northern Suburbs, Cape Town. The precinct is located at the intersection of Main and Voorbrug Road, which uniquely houses a cohort of public and private buildings; namely Delft Police Station, Delft Central Clinic, Delft Central Library, the Civic Centre, Caltex Petrol Station and more recently the Shoprite Mall. Based on currently developing group mapping new understandings of the conditions of public infrastructure in Delft North are reflective of a common problem pertaining to Global South cities – poor general investment in public institutional buildings and weak state/civil society alignment. The conditions of public infrastructure in Delft are seemingly fragmented, complex and remains the most underdeveloped realms of Delfts' built and social fabric. I argue, poor investment and underutilisation has led for public infrastructure becoming largely irrelevant and, due to its unevolved nature and its inability to adapt to changing urban conditions, it does not fulfil the needs of the Delft demographic as efficiently as it could. Spaces like public libraries, civic centres, sport facilities and police stations take on gated facades inviting timely dead spaces and dangerous landscapes.

The research aims to probe why state buildings/public infrastructure operate, exist and currently interact with civil society in traditional and outdated ways. Civic spaces (which refers to buildings and built spaces typically provided by and seen as state assets of the South African government) now exists as singular, inefficient spaces separate from the practices of public, everyday life. Because of the ill nature of these traditional civic spaces, they do not foster the mechanisms to lubricate efficient state/civil society relationships to harvest social capital from them. Part of this argument is questioning state reliance on NGO community policing and the function of the civic realm as well as future policy 're-scription' and the design of civic spaces.

ABSTRACT

This research will draw on loosely structured interviews with local actors as well as associations practicing in Delft that pertain to civic engagement. Group and individual mapping are also tools to interpret and further analyse contextual factors such as power dynamics and 'oppositional' forms of citizenship, safety and crime factors etc. in order to spatialize civil society efforts at organisation and ways in which state 'manages' civic spaces in relation to private institutional spaces.

The purpose of this research is to contribute to growing knowledge of African urbanism contextualised in Global South literature, as well as understanding and rethinking land use patterns of public institutions. In addition, it is also to make use of case-study methods to analyse formations and transformations of civic spaces over time. Lastly, it is to contribute to knowledge on civic spaces as sites of initiation of collective actions and civil society efforts at organisation while grappling with the controls and constraints imposed by state and capital interventions.

LINDIWE MTHIMUNYE

I am currently enrolled for a MSc Degree in Chemical Engineering at UCT under the c*change catalysis research. I hold a BSc. Degree in Chemical Engineering attained at UCT. I decided to pursue a MSc degree as I believed the experience will advance my research, analysis and communication skills. I have great interest and passion about the energy-producing industries and the impact they have on environment. This is why I decided to do my research in catalysis, which focuses on the development of alternative and sustainable ways of producing energy. I strongly believe in knowledge sharing and mentorship. I have faith that I can efficiently use the knowledge and skills I have gained to help someone achieve their goals. It is therefore a personal goal of mine to invest more in helping and empowering others, especially young people. Exercising the body and the mind is still on the top list of my personal goals.

Supervisors
Dr Nico Fischer & Prof Michael Claeys

Department
Chemical Engineering

Research Title
Ni-Ga based catalysts for low-temperature CO2 hydrogenation into Methanol.

ABSTRACT

Most of the energy used globally is from fossil fuels derivatives such as oil, natural gas and coal. These resources have been reported to be depleting and the high amount of carbon dioxide (CO_2) which is considered a major greenhouse gas is still of great concern. The CO_2 hydrogenation to methanol has been considered as one of the most promising processes for the utilisation of CO_2 [1]. This process addresses both the concern about the high CO_2 atmospheric concentrations by using CO_2 as a raw material; and the need for alternative energy sources since the methanol can be used as a precursor in fuel synthesis.

There is a growing interest in the development of a suitable catalyst that can selectively hydrogenate CO_2 to methanol. It has recently been discovered that Nickel-Gallium (Ni-Ga) bimetallic components show great potential for the hydrogenation of CO_2 to methanol; displaying high activity and selectivity [2]. The development of a low-cost catalyst which is active at low operating conditions is beneficial, as it would reduce the production costs of the methanol synthesis process.

The objectives of this project are to find (a) standard methods for the synthesis of the aforementioned Ni-Ga bimetallic compounds, comparing co-precipitation and reverse micelle (b) Analyse the Ni-Ga composition which exhibits high methanol yield and selectivity (c) Examine the deactivation of such catalysts under realistic conditions during the methanol synthesis reaction; using techniques such as the in situ magnetometer (developed at UCT) and in situ XRD.

[1] Li, C., X. Yuan and K. Fujimoto (2014). Development of highly stable catalyst for methanol synthesis from carbon dioxide. Applied Catalysis A: General 469: 306-311.
[2] Sharafutdinov, I., Elkjaer, C.F., Carvalho H.W.P., Gardini, D et al. 2014. Intermetallic Compounds Of Ni And Ga As Catalysts For The Synthesis Of Methanol. Journal of Catalysis 320: 77-88.

MEHDI SAFARI

I am a PhD graduate from the Department of Chemical Engineering (UCT) and Postdoc at CMR. I received several awards for academic excellence. In 2005, I was elected as an outstanding researcher in the Engineering Department. In 2006, I was elected as the Top Engineering Student in Iran, receiving a commemorative board from the president of the Iran.

I received a Silver Medal from the Moscow International Salon of Innovation and Investments (Russia, 2010) and a Gold Medal in the International Expo on Innovation and Invention (Malaysia, 2011). Also I was awarded first prize for the Best Student Paper and Poster at SAIMM MinProc 2013 and the Outotec Young Talent award at the international Minerals Engineering conference 2013. Moreover I was awarded IMPC Student Award in the International Mineral Processing Congress 2014, Santiago, Chile. Recently, I got Best Student Presentation Award at CMR Research Day 2014 and 2017 and Student Leadership Awards 2016 in UCT.

Supervisor
Prof David Deglon

Department
Chemical Engineering

Research Title
The Effect of Energy Input on the Flotation Rate Constant

ABSTRACT

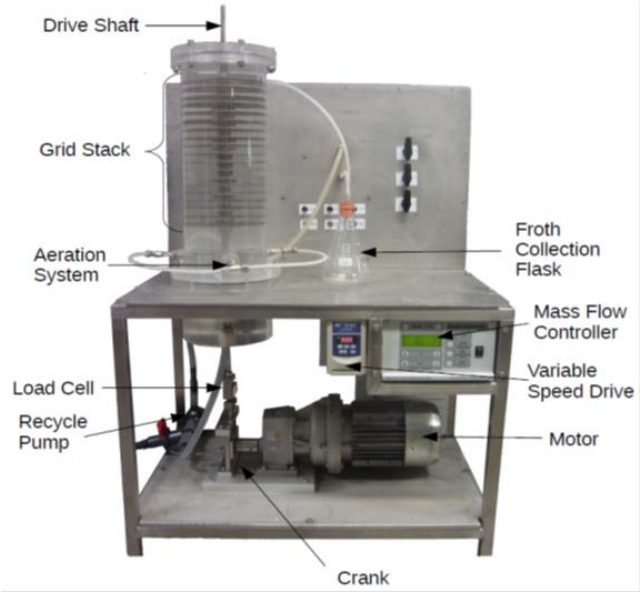
Energy/power input in a flotation cell is an important parameter which, if optimised, can increase the flotation rate. The optimum energy/power input within a flotation cell is still a matter of conjecture and there is a need for a better understanding of the effect of energy input on flotation kinetics.

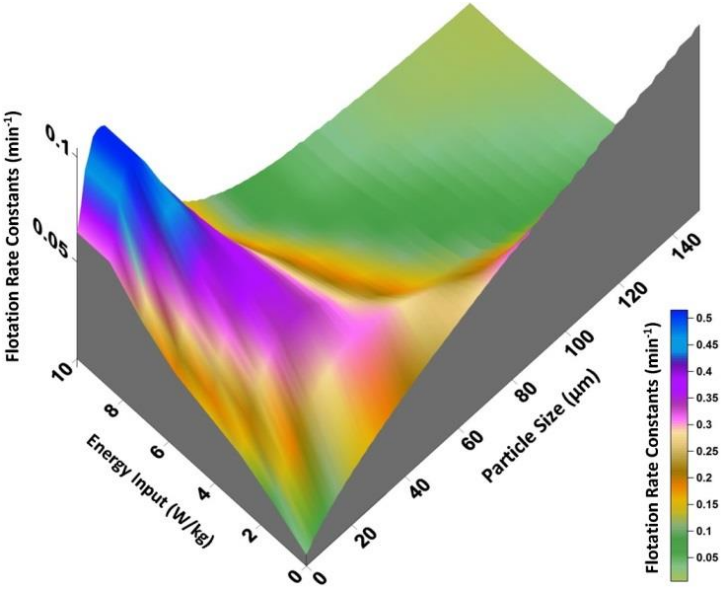
This study investigates the effect of energy/power input on flotation kinetics in an oscillating grid flotation cell (OGC). A pilot-scale OGC was designed and constructed in this study. Experimental flotation results show that the effect of energy input on the flotation rate is strongly dependent on the particle size and particle density and less dependent on bubble size and contact angle. In order to extract as much information from this large flotation data set as possible, it was decided to model this using a suitable kinetic model. Simulated flotation results for fine particles compare well to the experimental data in terms of both trends and magnitude.

Furthermore, this study presents and evaluates an attachment-detachment kinetic flotation model for predicting the effect of energy/power input on the flotation rate constant. The model relates mineral recovery to particle-bubble attachment and detachment rate constants and the gas residence time in the flotation cell. An extensive flotation data (over 10000 data point) is used to derive semi-empirical correlations for the relationship between the attachment/detachment rate constants and the particle size, bubble size, collector dosage, particle density and energy input. This data was obtained from experiments conducted in an OGC during this project over a wide range of particle sizes, bubble sizes, collector dosages and energy inputs using six different minerals.

The model is tested and evaluated against other data sets from the flotation literature. Subsequently, the model is used to predict trends in the flotation rate constant as a function of energy input at various operating conditions.

ABSTRACT


Drive Shaft
Grid Stack
Aeration System
Froth Collection Flask
Mass Flow Controller
Variable Speed Drive
Load Cell
Recycle Pump
Motor
Crank


Flotation Rate Constants (min-1)
0.1
0.05
10
8
6
4
2
0
Energy Input (W/kg)
0
20
40
60
80
100
120
140
Particle Size (μm)
Flotation Rate Constants (min-1)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05

MOHAMEDJAFFER GULAMHUSSEIN

Having completed a BSc degree in Civil Engineering, I decided to purse a master's degree in wastewater treatment as I believe it has a high resource recovery potential.

"I believe research in this field could be the future of wastewater treatment"

The current wastewater system used is energy intensive and unsustainable.

My goal is to add to research aimed at using the wastewater to generate power. This technology is fairly new, and I believe research in this field could be the future of wastewater treatment.

Supervisor
Dr Dyllon Randall

Department
Civil Engineering

Research Title
Investigating Plant Microbial Fuel Cells for electricity production

ABSTRACT

Wastewater treatment accounts for 3-5% of the total electricity demand in developed countries. However, wastewater is estimated to have 9.3 times more energy than which is consumed to treat it [1]. A microbial fuel cell (MFC) can potentially be used to treat wastewater and produce electricity. The problem associated with using MFCs is efficiency and longevity. Literature has shown that the efficiency can be increased by incorporating plants in a fuel cell [2] because they provide additional organics for the bacteria (therefore increasing power).

The research undertaken therefore will try to answer the question, "Can we incorporate plants to treat and stabilise thickened domestic wastewater sludge and generate sufficient electricity?".

The two main objectives of this project are to:

- Use South African indigenous plants (three species will be tested) and develop a working plant microbial fuel cell. The goal is to achieve a power density greater than 3000mW/m2. The possibility of stabilising waste activated sludge cakes (sludge that is thickened and dumped on a landfill site) will also be investigated.
- Develop a methodology of experimentally quantifying organics released from plant roots. The quantity could be related to the power produced. If time allows, an empirical relationship between organics and power will be established after standardising other elements of the fuel cell such as electrodes, plant species, mass of soil etc.

To carry out the first part of the project, an indoor green house will be set-up. The plants will be grown in buckets using thickened waste activated sludge as a soil medium. The power generated will be monitored using voltmeters that can log data. The cell will be optimised to increase power production by varying electrodes and plant species.

ABSTRACT

The methodology for the second part will be developed after an optimised cell design is achieved. This will allow an empirical equation relating organics to power to be developed.

The lessons learnt in this project will be further developed into a continuous system to mimic real plants and wetland-type conditions. This research could help us convert wastewater treatment plants into resource recovery plants where the emphasis is on recycling and reuse rather than merely treatment.

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[2] Xu, B., Ge, Z. & He, Z. 2015. Sediment microbial fuel cells for wastewater treatment: challenges and opportunities. Environmental Science: Water Research & Technology. 1(3):279-284. DOI:10.1039/C5EW00020C.

MOTLOKOA KHASU

I started my primary school at Roman Catholic school in Saint Monica Lesotho. I then went to a boys school Sacred Heart High School. I went to the University of Lesotho where I spent one year doing general BSc before getting a transfer to the University of Cape Town and furthered into a Master's degree in the same department. I am currently doing my PhD in catalysis. The reason I did research was that I was curious to explore my own boundaries and abilities and to get off the beaten path and work my way through the woods.

Research also gives on intellectual freedom and self-development. More importantly, experimental research is fun. There's always an unexpected challenge which requires an original and preferable quick fix. My personal goal is really not to be successful and famous, but to push the conversation especially about marginalised groups until we are all equal, because until we are all free nobody is free.

Supervisors
Dr Nico Fischer & Prof Michael Claeys

Department
Chemical Engineering

Research Title
New Support Materials for Fe-based Fischer-Tropsch Synthesis

ABSTRACT

Supported iron catalysts are important for the Fischer-Tropsch synthesis of liquid fuels derived from coal syngas with low H2/CO ratio [1]. One important focus in the development of this process is the enhancement of the catalyst activity by modification of the catalyst with chemical, reduction and structural promoters (K, Cu, Mn, Mo, Mg, La, Ca, Ce, Zn, Cs, Rb and zeolite) [2].

Reports have shown that promoters like potassium can improve activity and selectivity, and in some cases the activity reaches maximum with increasing promoter content, and decline with further addition of the promoter [3]. Even though potassium is a potent promoter for iron catalyst, at higher temperatures it migrates to cooler temperatures at the centre of the catalyst particles, deactivating the outer part of the catalyst because of promoter. The inner part of the catalyst is also deactivated due to excess promoter that causes high adsorption of carbon, leading to formation of coke. The mobility of potassium under reaction conditions is another challenge as it results in a highly dynamic system with significant fluctuations in catalyst performance. The main project rests on addressing the above problem by fixing the promoter in the structure of the perovskite, hence preventing any movement during Fischer-Tropsch synthesis. In this way, information about promoter content and location is always available [4]. Perovskites are mixed-metal oxides that have attracted much scientific attention due to their low price, adaptability and thermal stability. They generally have the formula ABO3 or A2BO4 (A and B are cations of different sizes, and O is the anion that bonds them), exhibiting a range of stoichiometries and crystal structures [5].

[1] P.H. Emmett, Reinh. Publ. Catal. 4 (1961).
[2] F.E.M. Farias, R.C.R. Neto, M.A.S. Baldanza, M. Schmal, F.A.N. Fernandes, Braz. J. Chem. Eng. 28 (2011) 495 – 504.
[3] J. R. Anderson, M. Boudart, Catal.: Sci. and Technol. (2012) 1 – 18.
[4] P. Jana, C.M. Montero, P. Pizarro, J.M. Coronado, D.P. Serrano, V.A. de la O'Shea, Int. J. hydrogen energy. 39 (2014) 5283 – 5290.
[5] R.J.H. Voorhoeve, J.P. Remeika, P.E. Freeland, B.T. Mathias, Sci. 177 (1972) 353.

NIRA JAGADEESAN

I graduated with a BSc in Electrical Engineering from UCT in 2016. During my undergraduate final year, I developed a keen interest in Power Systems and Energy. Having lived in India, Botswana and South Africa, I personally experienced the power outages that plague all three countries caused by an increasing demand for energy that the existing generation infrastructure does not have the capacity to meet. And so, I was inspired to pursue my MSc in Electrical Engineering. I was particularly drawn to the emerging potential of blockchain technology in energy systems, which has subsequently become the core focus of my research. Upon successful completion of my masters, I would like to go on to work in the Research & Development Department of a reputable company, where I would get an opportunity to be a part of projects designed to help solve the energy crisis in the country and make significant contributions towards sustainable development.

Supervisor
Mrs Kehinde Awodele

Department
Electrical Engineering

Research Title
Demonstration of Decentralized Energy Trading Using Blockchain Technology on the Multichain Platform

ABSTRACT

Blockchain technology was an algorithm initially developed for the trading of cryptocurrency, such as Bitcoin, in financial markets. It has since then been identified to harbour potential uses in other areas. Particularly, in the renewable energy sector where the distributed ledger system that underpins this technology can be used to facilitate and monitor peer-to-peer renewable energy trading in a decentralized power distribution network.

Some of the features of this technology that make it ideal for this application are its immutability, transparency and distributed consensus mechanism. In the research conducted thus far a proof of concept of the system was implemented using the open source blockchain platform called Multichain. A private blockchain network with a three-node system was set up on a single server. The first node was designated as the administrator node responsible for the issuing of assets and granting of permissions. The second node was given the permissions of the energy producer and the third node was the consumer.

Two assets were issued by the administrator node:
1. Energy – representing the physical renewable energy generated in kilowatt hours (kWh)
2. Tokens – representing the real-world currency that would be used to purchase the energy in Rand (ZAR)

The producer node was issued with 1000 energy units and the consumer node was issued with 5000 tokens. A simple transaction was executed whereby 200 KW of energy was sold, from the producer to the consumer, in return for 100 tokens. The experimental results showed how the blockchain system could be used to trade renewable energy, generated from roof top solar panels for example, with consumers nearby. The transactions once completed cannot be tampered with, solving the issue of security.

ABSTRACT

Furthermore, there is no need for a central utility to manage the transactions as the blockchain automates this process. In a practical scenario the end users will interface with the blockchain network using smart meters.

Going further, various case studies will be implemented to model real-life scenarios of generation and load using smart contracts. Multichain does not support smart contracts and thus alternate means will have to be identified. Geth is the Go-lang implementation of Ethereum which can be used to set up a private blockchain network. It is however, computationally intensive and requires a lot of programming using APIs that are constantly in development and thus not very stable. Alternatively, the use of Ethereum testnets, such as Ropsten and Rinkeby, are popular for testing of decentralized applications and they have the added benefit of supporting smart contracts, making them ideal for testing real life case studies.

NONTSIKELELO DYASI

I am a young African woman who began her education in the humble town of Mthatha in the Eastern Cape.

"A love of seeing my ideas come to life lead me to study chemical engineering"

Challenging the current thought pattern and a love of seeing my ideas come to life lead me to study chemical engineering.

After completing my undergraduate degree, I still needed more skills to be able to solve the critical issues that face the African content. Postgraduate studies would sharpen my ability to think critically and solve societal problems.

Supervisors
Mr Gerard Leteba & Prof Eric van Steen

Department
Chemical Engineering

Research Title
The systematic investigations of binary surfactants and annealing time on morphological evolution of Co nanostructures

ABSTRACT

A study on cobalt nanoparticle preparation was conducted to elucidate the effect of synthesis variables on size distribution and particle shape. Methods that have been used for cobalt nanoparticle synthesis include reverse micelles and thermal decomposition of an organometallic precursor. However, the cobalt nanoparticles were synthesised by reduction of a metal salt (Co2(CO)8) with the metal growth being controlled by organic molecules (surfactants). The size, shape and metallic dispersion can be controlled during synthesis by the temperature, precursor/surfactant ratio and surfactant combination. In this study the metal salt was dissolved in benzyl ether and surfactants were added. Different combinations of surfactants were used such as: Oleylamine (OAm) /Trioctylamine (TOA), Octylamine (OA)/ TOA and OAm/OA.

The effect of reduction time on shape and size of the cobalt nanoparticles was investigated by sampling the reactor every 20 min for 3 times. The synthesised nanoparticles were characterised using Transmission Electron Microscopy (TEM). The results indicate that all surfactant combinations formed cubic particles. However, it can been seem that OAm/TOA produced well defined cubic particles that the other surfactant combinations. Particle size increases with reaction time as can be observed in Figure 1. An analysis of the on the effect of surfactant combination and reduction time will be presented.

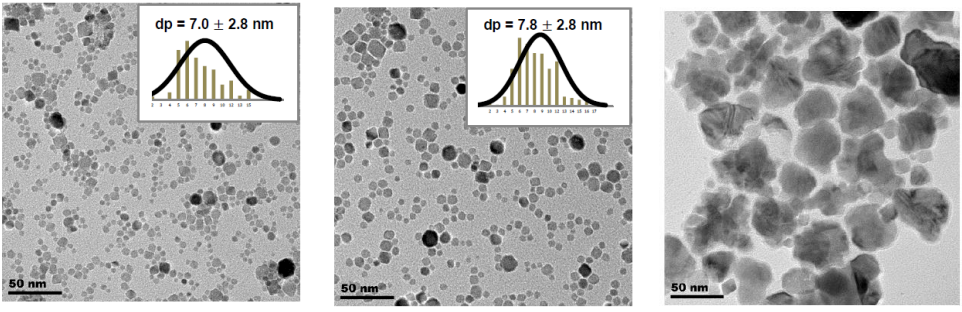

Figure 1: TEM images and size distribution for metallic cobalt prepared with OAm/TOA sampled at times (a) 20 min, (b) 40 min and (c) 60 min.

QUBEKANI NGULUBE

I obtained a BSc. in Applied Biology and Biochemistry from the National University of Science and Technology, Zimbabwe. I worked briefly, as a Product Development Chemist for Zimbabwe Pharmaceuticals before joining Anglo American Research, South Africa as a Research Technologist. In 2011 I joined the Centre for Bioprocess Engineering Research (CeBER), UCT for postgraduate research.

My MSc study was on heap bioleaching, and generated fundamental understanding important in the optimization of heap bioleaching and hence metal recoveries, and in environmental engineering applications. I am currently in progress with PhD study focusing on the consumption of carbon dioxide (CO_2) by microalgae.

I have a passion to contribute positively to society through innovative research that enhances sustainable approach to production processes.

Supervisor
Prof Sue Harrison

Department
Chemical Engineering

Research Title
Carbon dioxide capture using microalgae in different CO_2/HCO_3^- ratios

ABSTRACT

There is worldwide concern about global warming caused by emission of greenhouse gases, mainly CO_2. There is an urgency to mitigate CO_2 emission. This is being addressed using CO_2 capture, storage and cycling methods. Microalgae have been identified for potential use in CO_2 capture.

Productivity of microalgae in open pond systems prevalent in large-scale operations is typically limited by mass transfer of CO_2. Mass transfer of CO_2 to support algal growth can be divided into gas-liquid transfer and the subsequent CO_2 uptake by algae cells. Carbon dioxide is known to speciate into three inorganic carbon species, namely CO_2, bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}), based on the pH of the media. The mechanism of CO_2 uptake by algae cells depends on the carbon species present in the media. Algae can take up CO_2 and HCO_3^- whilst CO_3^{2-} is not utilised. While CO_2 uptake rates are reported for some algal species in literature, inconsistent reactor types and operating conditions make comparison difficult, to select the species that take up the most CO_2.

This research involves development of novel methodology to measure CO_2 uptake by microalgae in both CO_2–rich and HCO_3^--rich solutions, to identify algae species that take up the most CO_2. Furthermore, the research investigates the effect of CO_2 and HCO_3^- on algae productivity. The outcome of this research is the fundamental understanding to form the basis for optimization of CO_2 uptake using microalgae. Furthermore, the methodology developed for measuring CO_2 uptake will be useful in the screening of microalgae to identify key algae species for sustainable application in large scale CO_2 capture. This is all important regarding mitigating global warming whilst also contributing to economic growth through various products that can be obtained from algae.

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ROSALIND STEGMANN

I obtained my BSc in Chemical Engineering at UCT before commencing postgraduate studies in 2016. I am currently an MSc Student in the Catalysis Department, focusing on iron-based catalysts in Fischer-Tropsch synthesis.

"So that I can help others…"

My decision to do research stemmed from my then lack of interest to work in industry and also my hope to one day pursue a career in academia.

My personal goals are to complete my master's, followed by my PhD; to become more involved in tutoring so that I can help others while improving my confidence and ability to interact with people and to one day obtain a law degree, since law has always been one of my interests.

Supervisors
Dr Nico Fischer, Hendrik Hotzé, Prof Hans Niemantsverdriet & Prof Michael Claeys

Department
Chemical Engineering

Research Title
Oxidation and carburization of iron-based Fischer-Tropsch synthesis catalysts captured in-situ

ABSTRACT

Fischer-Tropsch synthesis (FTS) is an industrial process for the conversion of synthesis gas to liquid fuels and other valuable chemicals using cobalt or iron-based catalysts. A major disadvantage associated with the use of iron catalysts is its high deactivation rate [1,2]. Although controversy regarding the active phase in iron-based catalysts still exists, it is generally accepted that iron carbides are active; while magnetite is inactive [3]. Water, one of the main by-products formed in FTS, is thought to have a significant influence on phase composition and catalyst stability [1,4]. Studies have shown that the presence of water causes oxidation of the iron carbide phase to magnetite [2,4], which results in severe catalyst deactivation [1,3].

In this work the oxidation and re-carburization behaviour of an unpromoted iron catalyst and a 5 wt% potassium promoted iron catalyst is studied using the unique in-situ magnetometer developed at UCT [5]. Both catalysts are carburized to relatively pure Hägg carbide (χ-Fe5C2) prior to being exposed to FTS conditions at 275 °C, the temperature for medium temperature FTS. The oxidation of the carbide can be detected via an increase in magnetisation due to the formation of magnetite and its reversibility via a corresponding decrease in magnetisation. Importantly, these observations can be done at fully relevant industrial reaction conditions.

The results for the unpromoted iron catalyst show that the oxidation of the iron carbide phase starts upon addition of 2 bar water and increases until 4 bar water addition when full oxidation is reached. In terms of the potassium promoted catalyst, oxidation of the iron carbide phase starts with 3 bar water addition and increases until full oxidation is reached with 6 bar water.

ABSTRACT

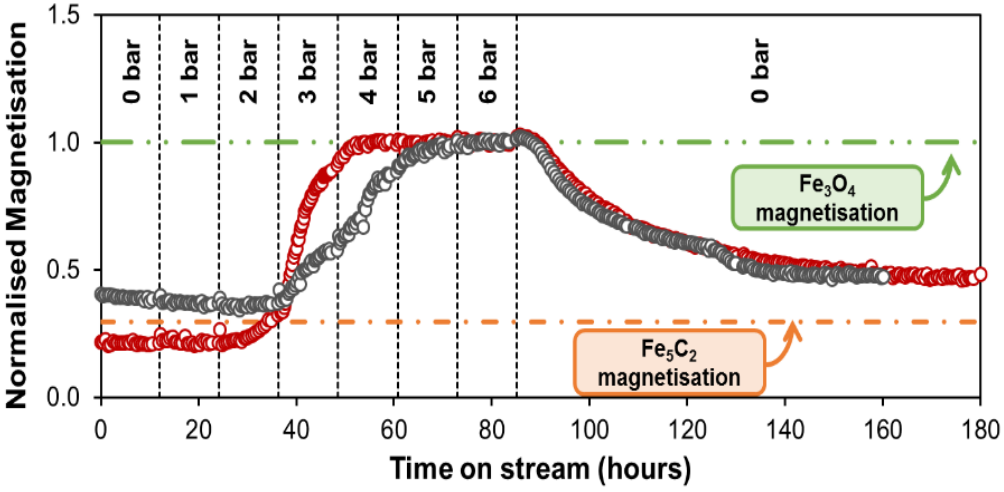

Figure 1: Change in magnetisation as a function of PH2O for an unpromoted and a potassium promoted iron catalyst

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STACEY SHIELD

I completed my BSc in Mechatronics at UCT in 2014. My interest in bio-inspired robotics started with my final year thesis topic: a robot using a spider-inspired aerial control mechanism.

"I've become more and more fascinated by the biological side of my research…'

Presenting a paper about this project at IROS the following year was an exciting and rewarding experience that inspired me to continue down the research path.

I've become more and more fascinated by the biological side of my research, so my goal following the completion of my PhD is to work on a postdoctoral project into bipedal locomotion in partnership with the Royal Veterinary College in London.

Supervisor
Dr Amir Patel

Department
Electrical Engineering

Research Title
Limiting Factors on Rapid Deceleration in Fast Quadruped Robots

ABSTRACT

The research documented in this poster examines the trade-off between manoeuvrability and stability for a bipedal robot during deceleration. This trade-off arises because the large horizontal frictional

forces necessary to slow the robot down create pitching moments that tend to topple the body forwards. The aim is to determine how possible stopping motions are affected if the robot is forced to decelerate while maintaining zero rate of change in angular momentum (ZRAM), a widely-used metric of dynamic stability in legged robotics. To investigate this, over 4000 simulated motions were generated through trajectory optimization of a simple bipedal model. The ZRAM condition was compared to a practical stability baseline: the model was not allowed to fall over, and had to finish in an upright position with both feet on the ground. As would be expected, the baseline robots were able to stop in a much shorter time and distance than those subjected to a stricter stability criterion, with greater reductions possible through the addition of a dedicated stabilizing limb (an arm, for instance). Additionally, regardless of the stability criterion used, the model tended to use stopping motions which allowed it to stabilize itself while decelerating (Figure 1.A) rather than those which maximized the decelerating forces (Figure 1.B). These results indicate that the ability to regulate the pitch of the body while decelerating is paramount to achieving a rapid stop, and therefore it is proposed that any generalized deceleration model must include 1) a rigid rather than point mass body and 2) a stabilizing mechanism.

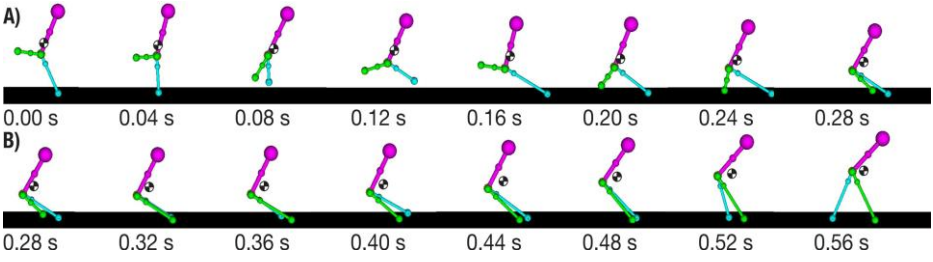
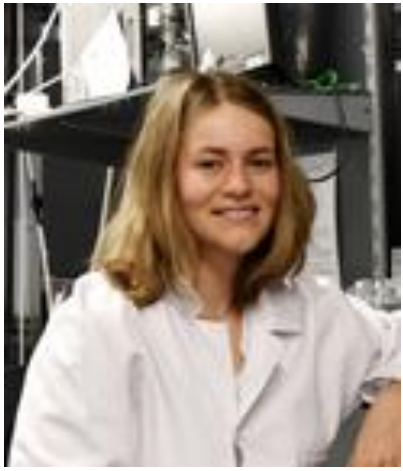


Figure 1: Decelerating motions arising from trajectory optimization of a simple bipedal model

SUZANNE LAMBERT



I studied a Bachelor of Science in Civil Engineering as my undergraduate degree at the University of Cape Town. In my fourth year I chose to do my undergraduate project under Dr Dyllon Randall and began researching the growing solids from urine using MICP.

The project sparked my interest as it involved topics that I had never encountered in any of my coursework and thus presented a huge challenge and learning opportunity.

In addition, I was drawn to the project as it had specific pertinence to the ongoing water crises occurring in cape town and offered sustainable alternatives to the building practices we use today. My goal is to achieve the objectives of my project and 'grow' a brick from urine such that can be used in a real-world application.

Supervisor
Dr Dyllon Randall

Department
Civil Engineering

Research Title
Growing bio-bricks from urine: A nature inspired alternative to conventional technologies

ABSTRACT

The main aim of this project is to see if Microbial Induced Calcite Precipitation (MICP) can be used to produce bio-bricks from the urea present in urine. There are several strong narratives which indicate why such a process is pertinent to building practices of the future. One being that the current manufacturing processes used to produce building materials employ substantial amounts of energy which contribute to anthropogenic greenhouse gas emissions and resource depletion.

The MICP process can potentially reduce these energy requirements as the process happens at ambient temperature with little to no added mechanical energy. In addition, the process uses waste products, recovers resources and emits no CO_2. Furthermore, this process has the potential to alleviate the high energy required for wastewater treatment plants to remove nitrogen and phosphorus by integrating the separation of urine and excreta at source for the eventual production of bio-bricks. Urine can be collected in novel urinals that are pre-dosed with calcium hydroxide. This has shown to prevent the degradation of urea [1] while simultaneously producing a calcium phosphate fertilizer. The liquid component can then be used as a feedstock for the MICP process.

MICP induces urea hydrolysis by using bacteria to chemically breakdown urea into carbonate and ammonium ions. The excess calcium in the liquid, together with carbonate ions, combine to form calcium carbonate which can be used to “cement” lose material (such as sand) together. The preliminary results from this study have shown that real urine can be used to “grow” bio-solids and that they have the same compressibility strength as a 40% limestone brick [2].

ABSTRACT

In addition, we are the first research team in the world to show that human urine can be used to "grow" bio solids similar to the ones shown in Figure 1. The next phase of the project aims to "grow" a conventional brick using the same methods developed by Henze [2] as well as optimise the process in terms of strength and the reagents required. It is hoped that this new method for producing bricks will help create a more sustainable industry that uses natural processes with limited waste generation.

Figure 1: bio-columns grown from synthetic urine (Henze, 2017).

[1] Randall D.G., Krahenbuhl M., Kopping I., Larsen T.A., Udert K.M., 2016. "A novel approach for stabilizing fresh urine by calcium hydroxide addition", Water Research, 95: 361-369.
[2] Henze J, 2017. "A nature inspired approach to production of bio-solids from urine". MSc. Thesis, Environmental Engineering, ETH Zürich, Switzerland

THOBANI GAMBU

I am a 3rd year PhD student in the Catalysis Institute. I graduated with a BSc. degree in Chemical Engineering in 2013 and with an MSc. in Engineering specialising in Chemical Engineering in 2015, both from the University of Cape Town.

After almost a year of plant work as a process engineer at Richards Bay Mineral (RBM) and South African Breweries (SAB) I realised that research could be much more fulfilling than routine plant work.

I then joined UCT's Catalysis Institute and my short to medium term goals are to generate a comprehensive understanding of the catalytic processes occurring under ORR conditions. As my long term goal, I hope to expand my focus to cover a broader range of energy materials for both industrial application and academic curiosity.

Supervisors
Sandeeran Govender, Tracey van Heerden, Dr Melissa Petersen & Prof Eric van Steen

Department
Chemical Engineering

Research Title
Mechanistic pathways for oxygen removal over platinum-doped cobalt surfaces in the Fischer-Tropsch reaction

ABSTRACT

Metallic cobalt is the preferred catalyst for maximising liquid fuel product from synthesis gas in Fischer-Tropsch (FT) synthesis. Oxygen-containing species can be produced as reaction intermediates on the active surface [1]. In the H-assisted mechanism, oxygen has been suggested to leave the catalyst surface as H_2O instead of CO_2 [1]. Furthermore, it has been reported that oxygen coverage on the cobalt surface can compete with CO adsorption and can negatively influence CO dissociation [2]. This, substantiates the need for efficient removal of surface oxygen to obtain a highly active FT catalyst.

Platinum (Pt) is usually added to cobalt (Co) catalysts as a reduction promoter, but, it can also induce a higher turnover frequency in the FT reaction [3]. The increase in intrinsic activity is thought to be due to a change in the electronic nature of the active site [4], thereby changing the adsorption/desorption characteristics on the surface.

In this study, we investigate O* removal when Pt is incorporated into the Co lattice, i.e. where we expect there to be a change to the electronic nature of the active site. More specifically, we study surfaces in which cobalt has been doped with platinum, to create a Pt-doped surface or sub-surface layer, respectively. Other work already conducted on this type of surface has been limited to the direct water formation pathway, i.e. O* ⊠ OH* followed by OH* ⊠ H_2O * [5]. Here, we consider an additional reaction pathway for H_2O formation, 2OH* ⊠ H_2O * + O*. This reaction pathway has been reported to be energetically more favourable than the direct water formation [6].

ABSTRACT

Density Functional Theory (DFT) calculations were performed using the Vienna Ab Initio Simulation Package (VASP) [7]. The Co(111); Pt-doped Co(111); and Pt-doped sub-surfaces were used to model the O* removal reaction process. Reaction intermediates, O*, H*, OH* and H2O*, were adsorbed on one side of the slab surfaces. To probe the preferred position of a Pt atom, we used a slab model with 8 atomic layers and various degrees of layer relaxation.

Generally we found that surfaces doped with a Pt atom have a lower surface reactivity relative to that of pure Co(111); while a sub-surface doped with Pt has an increased reactivity. Using a micro-kinetic model, we show how this reduced reactivity influences the O* removal pathway at realistic FT conditions, resulting in much faster O* removal on the Pt-doped surface (2-3 orders of magnitude faster than on pure Co(111) surfaces).

[1] M. Ojeda, R. Nabar, A. U. Nilekar, A. Ishikawa, M. Mavrikakis, E. Iglesia, J. Catal. 272 (2010) 287.
[2] C-F. Huo, Y-W. Li, J. Wang, H. Jiao, J. Phys. Chem. C 112 (2008) 3840.
[3] D. Nabaho, J.W. (Hans) Niemansverdriet, M. Claeys, E. van Steen, Catal. Today 261 (2016) 17.
[4] L. Guczi, Catal. Today 101 (2005) 53.
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TINASHE CHIPAKO

I currently hold a BSc in Civil Engineering from the university of Cape Town, after completing my undergraduate studies in December 2017.

"I would like to positively contribute towards sustainability…"

I am currently continuing my studies in an MSc degree in Civil Engineering, specialising in water quality. After having thoroughly enjoyed the final year thesis all engineering undergraduates are required to complete, I found myself wanting to pursue further studies to expand my knowledge on water quality.

Personally, I would like to positively contribute towards sustainability in any capacity applicable. Currently, I am aiming to further my knowledge pertaining to recycling of waste products to create valuable products such as fertilisers.

Supervisor
Dr Dyllon Randall

Department
Civil Engineering

Research Title
Investigating the feasibility of maximum resource recovery from anthropogenic urine

ABSTRACT

Urine accounts for about 80%, 56% and 63% of the nitrogen, phosphorus and potassium found in domestic wastewater streams, respectively [1]. These nutrients are all important ingredients in commercial fertilizers It is estimated that urine alone could contribute 22% to the global phosphorus demand [2].

Several benefits can be achieved through decentralizing urine collection to recover nutrients. Barriers which prevent this from occurring include the transportation logistics of urine from where it originates, the financial feasibility of decentralized treatment and the selection of appropriate urine treatment technologies. Moreover, retrofitting of existing urinals and toilets with urine diverting technologies is expensive.

The objectives of this research include, but are not limited to, the following:

- A review of literature regarding resource recovery from urine.
- The Design of a ceramic nutrient recovery urinal for urine collection and on-site fertilizer production. This will be based on an existing urinal prototype created within the UCT water research group & future water institute in 2017.
- Investigate the transportation and logistics of installing nutrient recovery urinals within a business district for optimal resource recovery and profits.

The methodology will include the creation of a graphical decision-making tool pertaining to nutrient recovery techniques, a geospatial analysis of the transportation and logistics of a system incorporating decentralized treatment of urine and a revised design of a novel nutrient recovery urinal.

ABSTRACT

The outcomes of this research will aid future researchers and practitioners alike in determining the most sensible treatment techniques for source separated urine to recover all desired resources. Moreover, an assessment of a hypothetical system incorporating decentralized treatment, based on transportation and logistics, will provide insight into the overall feasibility of such a system. Subsequently, the feasibility of implementing nutrient recovery urinals will also be assessed.

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WIJNAND MARQUART

I obtained my BSc degree in Chemical Engineering at the Utrecht University of Applied Sciences, The Netherlands in September 2015. During this degree I enjoyed two successful internships in Cape Town: at One Eighty Integrated Engineering Solutions, from August 2013 – January 2014 and at the South African Institute of Advanced Materials Chemistry, University of the Western Cape, from November 2014 – July 2015.

During the last internship I applied for a MSc position in Chemical Engineering at the Catalysis Institute, UCT. The conducted research during this MSc is shown by the presented poster.

After submitting my MSc thesis in February 2018, I started as a PhD candidate under the Catalysis Institute.

Supervisors
Prof Michael Claeys & Dr Nico Fischer

Department
Chemical Engineering

Research Title
Effect of synthesis protocols and potassium promotion on β-Mo2C in the Fischer-Tropsch synthesis.

ABSTRACT

The Fischer-Tropsch (FT) process, producing long chained waxes and transportation fuels, is competing with fuels derived from crude oils and its profitability is therefore dependent on the global oil price [1]. However, increasing the value of synthesized products could render the profitability of the FTS independent of fluctuations in the oil price (which are mostly due to global political trends). One way to achieve this, is to target long chained oxygenates. Oxygenates are platform chemicals which can through further processing, be converted to alternatives for synthetic fuels or industrial chemicals and polymers [2]. Oxygenates are a typical by-product of the FT synthesis but due to selectivity limitations of the applied catalysts, no commercial FT based process exists which produces oxygenates at a significant yield [3].

Typically, transition metals such as Fe, Co, Rh and Ni are active for the FT synthesis. Based on reaction conditions employed, commercial Fe and Co based catalysts have been shown to produce between 6 and 12 % oxygenates [4]. Rh has been shown to have a high oxygenate selectivity, but the associated high raw material cost becomes prohibitive for use as a commercial FT catalyst [5]. Catalysts other than the traditionally known FT active transition metals have shown promising results in terms of oxygenate selectivity. Transition metal carbides such as Mo2C, have been investigated under Fischer-Tropsch conditions. While the bare catalyst produces mainly methane and other hydrocarbons, upon promotion with potassium the selectivity showed a significant shift towards oxygenates [6].

This project investigates the use of potassium promoted molybdenum carbide as a catalyst for high oxygenate selectivity during the Fischer-Tropsch synthesis. β-Mo2C was synthesized and then promoted with different levels of potassium and its Fischer-Tropsch synthesis performance evaluated in a stainless steel fixed bed reactor. The influence of catalyst synthesis protocols, reactor pressure and temperature, feed gas space velocity, and K/Mo wt.% promotion on catalyst activity and selectivity were studied.

ABSTRACT

An unpromoted Mo2C catalyst reached CO conversions to ±40% at the conditions applied. Initial promotion of the catalyst with potassium showed a significant drop in catalyst activity, however, an increase in potassium content did not further decrease catalyst activity. The selectivity towards oxygenates was enhanced, yet it has a certain optimum promotion. Simultaneously, the oxygenate distribution shifted towards higher alcohols. The initial methanol content in the total oxygenate distribution was around 60%, following a decrease to about 20% upon potassium promotion (Figure 1).

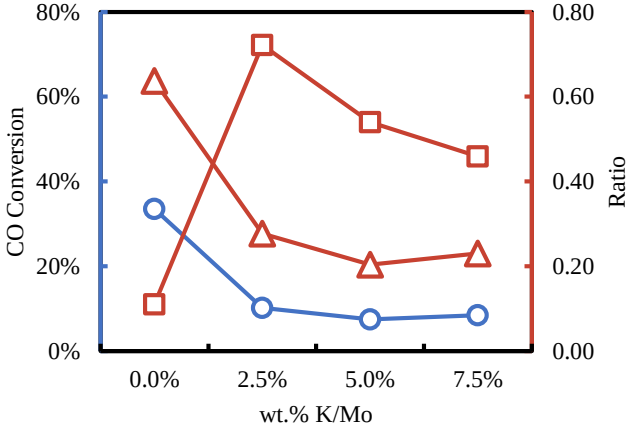

Figure 1: Effect of potassium promotion on the activity and selectivity of a β-Mo2C catalyst (squares = ratio of OH to HC, triangles = ratio of MeOH to total OH). Conditions applied: T = 300 °C, P = 33-45 bar, SV = 8 L/h.gcat-1

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ZWIVHUYA RAMUDZULI

I received a Bachelor of Engineering degree in Computer Engineering from the University of Pretoria in 2015. I am currently employed by the Square Kilometre Array South Africa (SKA SA) as a junior engineer. While working on the MeerKAT radio telescope project, I have been involved in embedded software development and hardware prototyping of time and frequency transfer over GPS and white rabbit systems. The MeerKAT radio telescope is a remarkable instrument that requires highly accurate time directly linked to international atomic time (TIA) and the associated universal coordinated time (UTC). The research. will provide a method to independent verify the timing accuracy of each receptor to UTC. I aim to complete my masters and contribute knowledge in the success of the largest and most sensitive radio telescope in the southern hemisphere.

Supervisor
Dr Francois Schonken

Department
Electrical Engineering

Research Title
Investigation into a GPS time pulse radiator for testing time-stamp accuracy of a radio telescope

ABSTRACT

In order to verify the accuracy of the end-to-end sample time tagging of the MeerKAT radio telescope, a portable instrument was designed to transmit a periodic signal that coincides with the UTC time. The instrument is less accurate than masers and dual-band GPS receivers [1,2], but is attractive in that it is independent to the timing system of the radio telescope. Laboratory tests of the GPS Time Radiator (GTR) showed its RF pulse to be at 1.65±0.1 μs after the UTC second.

Telescope tests revealed a 13.0±0.3 μs deviation from the expected timestamp value. This was later found to be due to a buffer in the digitiser FPGA and confirmed by pulsar timing.

The MeerKAT radio telescope situated at the Losberg site in the Karoo makes use of GPS receivers and atomic clocks for its time and frequency reference system. In order to verify the MeerKAT's time-stamp accuracy and beamformer delays, the GTR instrument was designed to verify that each antenna of the MeerKAT radio telescope was synchronised to UTC time.

The GTR instrument as shown in figure 1 consisted of five internal subsystems namely, power and operation controller, noise generator, bandpass filter, GPS timing module and an RF switch. The instrument was designed to transmit a wideband noise signal. The GPS timing module was based on the u-Blox M8F time and frequency reference module.

All antennas of the MeerKAT telescope were synchronized and data captured. According to our results, the GTR timing signal shifts with a total delay of 1.65±0.1 μs. The estimated transition time of the sampled signal on one antenna was estimated to be 13.0±0.3 μs.

ABSTRACT

Future work includes improving the shape of the transmitted signal, to study GPS timing errors and correction techniques and signal processing using a standard pulsar timing pipeline.

Figure 1: GTR MeerKAT test

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