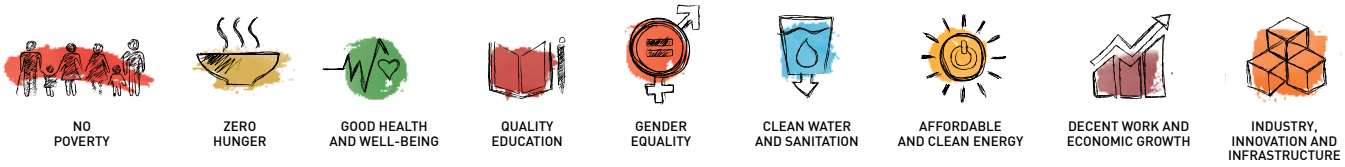
Innovation at UCT 2022

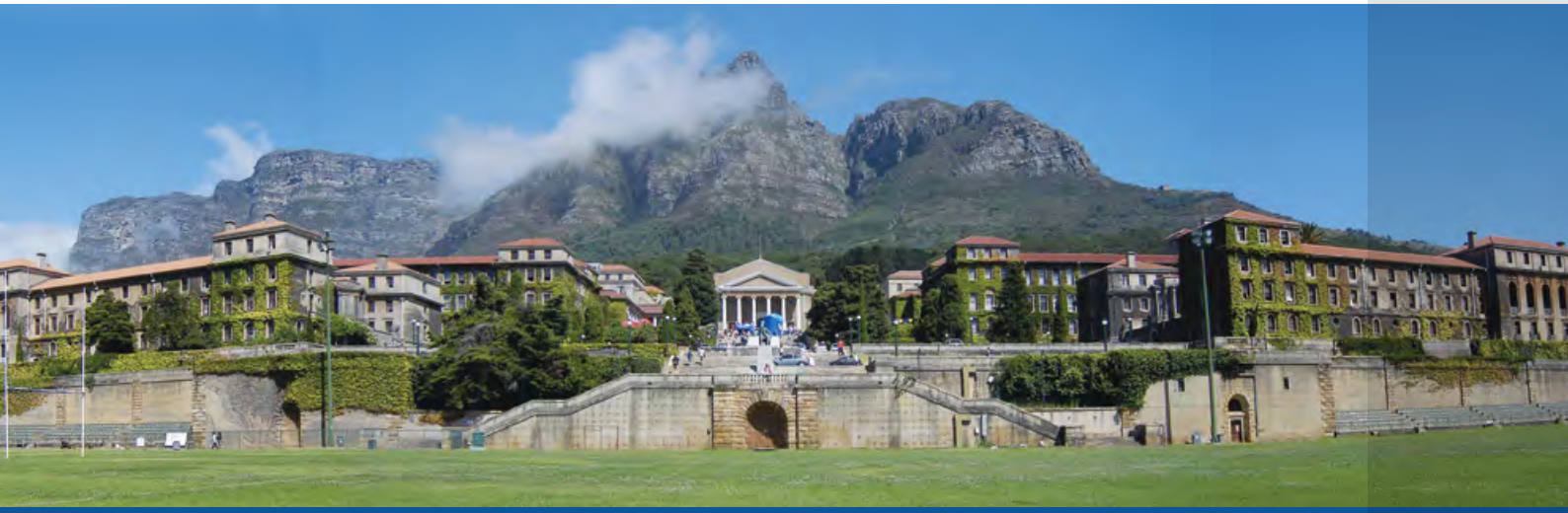
embedding innovation

Research Contracts & Innovation

Contents

The United Nations' Sustainable Development Goals (SDGs) are deeply integrated into UCT's Vision 2030, which has three key pillars: excellence, transformation, and sustainability.





Introduction

Excellence, with Transformation and Sustainability are the pillars that form the core of UCT's strategy, Vision 2030. Quoting from the website, *Excellence is the key trademark that should be visible in all UCT endeavours through the pursuit of achieving the highest standard of research, teaching and operations in order to contribute meaningfully towards more sustainable and equitable society.*

This edition of "Innovation at UCT", as the thirteen previous editions, showcases and acknowledges the excellence and achievements of our researchers as well as administrative staff in the innovation space. As you will learn, there is also a definite focus on the other pillar, Sustainability in the innovative research that is done, and the university is serving as a testing vehicle for some of these technologies.

Excellence, transformation and sustainability in the innovation space are not possible without knowledge transfer and sharing of experiences with the younger generation. Collaboration between RC&I and members of the academic staff have resulted in a number of excellent knowledge exchange courses and modules.

We are indeed moving towards an embedded approach to innovation at UCT.

Piet Barnard
Director, UCT Research Contracts and Innovation

with **thanks...**

There are a number of people and funders who make a valuable - and often pro bono - contribution that supports our innovation activities.

INTELLECTUAL PROPERTY ADVISORY COMMITTEE (IPAC)

IPAC makes the decisions regarding UCT Evergreen Fund investments, recommends the appointments to spin-off companies and needs to deal with the often urgent issues that arise in the life of fledgling start-ups. The committee provide guidance and steer policy development in the innovation space, striving for best practice. IPAC meets five times a year, excluding ad hoc meetings and round-robin decisions. **Prof Sue Harrison**: Deputy Vice Chancellor: Research & Internationalisation (Chair), **Dr Reno Morar**: Chief Operating Officer, **Mr Vincent Motholo**: Chief Financial Officer, **Mr Hardy Maritz**: Director Commercial Development; **Prof Jonathan Blackburn**; and **Dr Philippa Tumubweinee**

PRIVATE EQUITY ADVISORY GROUP (PAG)

PAG comprises a group of experts in the entrepreneurship and private equity investment space who advise both RC&I and IPAC on investments made by the UCT Evergreen Fund into spin-off companies. They propose deal structures and draw on their experience and sector knowledge. **Mr Chris Derksen** and **Mr Gasant Orrie**

INNOVATION BUILDER FUND INVESTMENT COMMITTEE

UCT provides a budget to support technology development and innovation to mature the UCT IP portfolio. The Innovation Builder Fund Investment Committee (formerly the TIA Seed Fund Steering Committee) awards up to R500,000 to projects. The committee comprises UCT representatives with different technical expertise, aligned with our technologies as well as external members who have technology development and/ or start-up company experience. The committee is chaired by **Piet Barnard**, Director: RC&I and there are currently 22 active projects. Funding is tranched and project progress (monitored by the RC&I team) is reported on at committee meetings, which are held quarterly. Committee members include: **Dr Caryn Fenner** (external), **Prof Kit Vaughan** (external), **A/Prof Melissa Densmore**, **Prof Neil Ravenscroft**, **Mr Abu Adams**

UCT-APPOINTED DIRECTORS AND SHAREHOLDER REPRESENTATIVES

Whilst numerous individuals are appointed as Directors to a variety of UCT companies and trusts, the list here only includes people who are appointed to spin-off companies that are commercialising IP developed through UCT research. Appointments are only permitted when UCT holds above a threshold equity amount of equity in a company. **Prof Petro Terblanche** - Strait Access Technology Holdings, **Mr Tony Pick** - Cape Bio Pharms and Elemental Numerics; **Dr Ntokozo Mthembu** - Cape Catalytix; **Dr Makhapa Makhafola** – HyPlat, **Ms Zanele Mbatha** – HyPlat, **Dr Sharon Blair** HyPlat, **Dr Susan Winks** – Registree Rocks and Nautilus Enterprises; and **Ms Tebogo Lefifi** – PST Sensors, **Ms Hema Vallabh** – Hydrogen Energy Applications, **Mr Rowan Spazzoli** – MariHealth Solutions

DEPARTMENT OF SCIENCE & INNOVATION (DSI) NATIONAL INTELLECTUAL PROPERTY MANAGEMENT OFFICE (NIPMO)

RC&I is in the third year of our fourth NIPMO-funded capacity development project. This has been a key enabler to establishing the RC&I technology transfer operation at its current level. The funding has supported new positions, that once trialled have been adopted by UCT, as well as a range of awareness-raising activities focused on both IP as well as the marketing of technologies. Support is provided to facilitate RC&I's engagement with industry and commercial partners in a variety of modes, including expos. NIPMO also provide a 50% rebate of expenses incurred by UCT in the protection of our intellectual property portfolio. This greatly extends the ability that UCT has to support this important activity. The support of NIPMO on a number of levels is gratefully acknowledged.

UNIVERSITY TECHNOLOGY FUND

UCT is a Special Partner of the University Technology Fund (UTF) which was established by the SA SME Fund. We appreciate the ongoing support from both the SA SME Fund (Pre-Seed and Seed-stage investments) and the UTF for investing in UCT companies and technologies. The relationship with the UTF Fund Managers, **Wayne Stocks** and **D'Niel Strauss** has helped to shape the nature and direction of our spin-off companies as they review our pipeline of investment opportunities.

Embedding Innovation

To most people, university campuses are synonymous with ideas around learning, research and, of course, socialisation. However, one of the underrated functions of these places of intellectual confluence is the propensity for inventive thinking and endless opportunity for innovation and experimentation.

The University of Cape Town (UCT) has embraced this idea with the establishment of the Khusela Ikamva ("Secure the Future") sustainable campus project. Along with Excellence and Transformation, Sustainability is one of the three pillars at the core of UCT's Vision 2030 strategy, and creating a more sustainable campus is one of the flagship associated endeavours.

Vice Chancellor Prof Mamokgethi Phakeng describes Khusela Ikamva as "a trans-disciplinary collaborative effort to set the university as a 'Living Lab' and maximise its reach and impact" as well as "a key enabler in transforming the institutional fabric of UCT to a more sustainable campus for collective innovation."

The idea is that staff and students across all spheres of campus collaborate on sustainability-focused research that has the potential to evolve into the implementation of real projects on campus. Projects are to be built around the five core themes of energy/carbon, water, waste, wildlife and social responsiveness.

Several Living Lab ideas are in development and set to be implemented once completed.

Yet even before the launch of Khusela Ikamva, UCT's campuses have proven to be fertile testing grounds for a range of other homegrown innovations. In the past, an anaerobic digester was tested by Prof Harro von Blottnitz at the Leo Marquard residence and the technology that established the business "WhereIsMyTransport" was tested as "WhereIsMyShuttle" on the UCT Shuttle services.

Over the next pages, we'll unpack some examples.

For more on Vision 2030, visit **https://uct.ac.za/transformation/vision-2030**

or more on Khusela Ikamva, visit **shorturl.at/aDJW3**

EMBEDDING INNOVATIONS

Pee-Cycling
An unlikely source of 'Liquid Gold'

For anyone with an awareness of just how important sustainable practices are for the future of our planet, the idea of wasting valuable resources is simply horrifying.

Yet, every time we flush the toilet after emptying our bladders, this is exactly what happens! Apart from the countless litres of drinking water going to waste, you might be surprised to discover that the product of your emiction is also worth repurposing.

Pee-Cycling, a UCT-based initiative, has made it their mission to contribute to the creation of more sustainable sanitation systems and recover valuable resources from urine.

While human urine only makes up 1% of the volume of domestic wastewater streams, it contains about 80% of the nitrogen (N), 56% of the phosphorus (P) and 63% of the potassium (K) present in these streams. NPK, for short, play a key role in plant nutrition and make up the 'Big 3' ingredients in commercial fertilisers.

Led by Dr Dyllon Randall, an Associate Professor in Water Quality Engineering and Environmental Sustainability, the Pee-Cycling team has developed a range of novel methods to recycle and reuse human urine instead of washing it down the toilet.

Embracing the idea of campus as a living laboratory, Randall says that they've made use of the New Engineering building to trial the broader pee-cycling concept.

"These on-going trials entail the collection of urine in fertiliser-producing urinals for the production of different fertilisers, water and bio-bricks in our lab," he says.

Let's take a closer look at each of these inventions:

The world's first bio-brick mold.

Pee Urinal

Dr Dyllon Randall and his students, Vukheta Mukhari and Suzanne Lambert.

The Pee-Cycling initiative, has made it their mission to contribute to the creation of more sustainable sanitation systems and recover valuable resources from urine.

Fertiliser-producing urinal

With the fertiliser producing urinal, urine is funnelled into a removable container housing calcium hydroxide (lime), which assists in the formation of a solid fertiliser. This process requires a lime-urine ratio of 10 grams/litre. Pee-Cycle's current prototype works with a 25-litre container, thus housing 250 grams of lime. The urinal is also completely waterless and does not need to be connected to a conventional sewage line to operate.

"When a person pees into the urinal, some of the powder dissolves and the pH of the urine increases resulting in the formation of solid fertilizer, rich in phosphorus," says Randall.

Once the container is full, it is removed and taken to a resource recovery facility where the fertiliser is recovered.

The fertiliser-producing urinal prototype has been trialled in UCT's New Engineering building since 2017 and is still in development, however it holds the potential to become a fixture in households and commercial buildings that seek to reduce their water consumption while also recovering valuable resources.

Urine bio-brick

In 2018, Randall and his team grew the world's first bio-brick' using the urea present in human urine.

Emanating from research conducted by then-civil engineering master's student, Suzanne Lambert, these bio-bricks are formed through microbial induced calcium carbonate precipitation (MICP), which is a natural process similar to the way in which seashells are formed.

The first step in the process is to collect fresh urine and stabilise it with calcium hydroxide to prevent any significant loss of urea. The urine is then added to loose aggregate material populated with Sporosarcina pasteurii, bacteria that produce the enzyme urease, which breaks down the urea in urine while producing calcium carbonate through a chemical reaction.

This calcium carbonate is then used as a bio-cement to glue loose sand particles together in the shape of a brick. Whereas regular bricks are kiln-fired at around 1 400°C and produce vast quantities of carbon dioxide, these bio-bricks are made in moulds at room temperature, making them a much more environmentally friendly option.

Fertilisers

The Pee-Cycle lab has conducted research around manufacturing both solid and liquid fertilisers. Solid fertilisers are manufactured using calcium-hydroxide to stabilise the urine, as with the fertiliser-producing urinal, while reverse osmosis (RO) is employed for the production of liquid fertilisers.

The RO process works in the same way it does for seawater desalination, says Randall.

"Basically, water is passed through a membrane under pressure leaving all the other components on the other side of the membrane," he explains. "In the case of using RO to produce a liquid fertilizer, the system essentially concentrates the urine and produces a water stream, meaning that the process has no waste stream."

The water produced from the RO process would have to be further treated if it were to be used for drinking. Alternatively, it could be used to flush toilets, water gardens and more.

Pee-Cycle is currently seeking funding for the construction and testing of a pilot urine treatment process for liquid fertilizer production as well as funding for the commercialisation of the fertiliser producing urinals. The pilot facility will also be operated at UCT to demonstrate larger-scale use and the fertiliser could be used on the university's gardens and sports fields.

RC&I has been instrumental in assisting them with potential fund raising opportunities as well as legal agreements with various stakeholders.

Watch a short video about the urine recycling research currently being conducted at the University of Cape Town at **shorturl.at/gkpV1**

Registree broadens base for employers and job seekers

Find out more at **https://registree.io**

The successful introduction of Registree at UCT shows how innovative privacy preserving technology can safely and responsibly connect students, universities and employers to reduce the frustration of hunting for jobs and bursary opportunities while complying with data privacy legislation.

Registree, which makes use of technology developed at the university, is an app founded by post graduate students pursuing their masters and doctor's degrees and one of their professors – Co-Pierre Georg of the Fintech Masters programme, who also holds the South African Reserve Bank Research Chair in Financial Stability Studies.

The platform is essentially a student data ecosystem that links UCT students' de-identified records to securely stored personal information, while the app directly links students to a multitude of potential employers and bursary providers without confidential information ever leaving the university's control. This saves both time and effort during recruitment.

"We created a platform where employers can search for their ideal graduate by degree and mark, invite them to an event and track if they are attending or not. After the event, the student can share their email address and personal details with the employer to take the employment process further." Student data does, however, not get stored by Registree: the aim is to show that successful business models can exist which do not involve the large scale storing and collection of data.

The fully automated solution runs on university information systems and servers and, once deployed, the system is fully automated, and Registree cannot make changes to the code, nor access or see the underlying data. The code is made open to universities to review at any point. Registree is compliant with both the EU's General Data Protection Regulation (GDPR) and SA's Protection of Personal Information Act (POPIA). The founders include students Allan Davids, Chandler de Kock, Christopher Maree and Sabine Bertram (Schaller).

Campus creates cross-section for locally-relevant sleep research

Find out more at **https://www.sleepscience.co.za**

During the past few months Sleep Science, a UCT spin-off company offering a range of services targeted at helping people improve their sleep, has been working closely with UCT's Human Resources (HR) department to trial a new corporate-wellness-focused service on campus.

"We've developed a sleep health screening in the form of a mini questionnaire that people can do easily online," says Dr Dale Rae, Director of Sleep Science and a senior researcher in the field of sleep and circadian rhythms. "It's designed to be implemented in the workplace through HR to form part of employee wellness efforts."

The screening was trialled among staff members at the UCT Educare Centre, and followed up with three short workshops focusing on various aspects of sleep health.

"We do this group-based session, but anyone whose questionnaire revealed that they may need additional help with their sleep are either referred to a specialist or we provide them with the one-on-one support they need," says Rae.

She adds being able to trial services like these among UCT staff members on campus provides an excellent opportunity to gain locally relevant insights, which is crucial in a field that is still largely Eurocentric.

"We found great value in the sessions assisting us to perform our responsibilities effectively and efficiently," says Natascha Hector, Head of UCT Educare Department. "Sleep forms a critical pillar in our staff's overall well-being and wellness.

The facilitators were accommodating and helpful, and addressed any concerns that were raised from the informed sessions."

There are also plans in place to conduct a similar trial with a group from UCT's Graduate School of Business.

Trans-disciplinary collaboration makes new force plate technology accessible

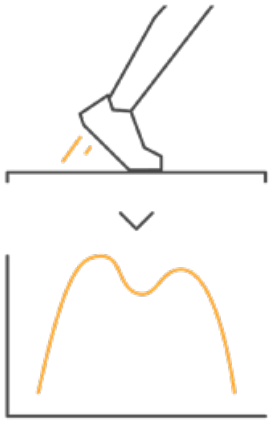
The launch of the spin-out company Acino Technologies, later in 2022, is an excellent example of the value of cross-disciplinary research. A collaboration between Prof Amir Patel, an electrical engineer whose research interests are Bio-Inspired Robotics and Biomatics, and Dr Yumma Albertus from the Department of Human Biology, whose research focus is neuro-muscular physiology, has led to the development of an advanced 3D force sensing system.

Force plate sensing systems, which consist of transducers that measure the change in electrical current through sensors as force is applied, are not new. They are typically used in medical and sports applications, for example, to study athletes in order to monitor and improve their performance or to monitor the rehabilitation of injured patients. They can be applied to contribute to physical rehabilitation in humans as well as animals.

The available systems are, however, expensive and only available at specialised centres, which makes sports performance coaching, neurological and orthopaedic rehabilitation inaccessible and unaffordable for most who need this service. It is notable that in South Africa, the occurrence of traumatic spinal cord injury (TSCI) is three times higher than the world average, which increases the scope for positive impact.

The new technology developed at UCT aims to address these hurdles. The inventors have developed a much more accessible mechanism for supporting rehabilitation in the fields of orthopaedics and neurology. Due to the improved affordability, it will now be possible to use force plates more widely in biokinetics practices, whilst the larger surface area will improve the practitioners' assessment of force and motion.

Patel is an associate professor in the Faculty of Engineering & the Built Environment's Department of Electrical Engineering, while Albertus is from the Health through Physical Activity, Lifestyle and Sport Research Centre (HPALS), Division of Physiological Sciences, in the Faculty of Health Sciences' Department of Human Biology. Through Acino Technologies Pty Ltd, the founders, along with student Devin Stickells, will acquire the exclusive rights from UCT to commercialise the technology.



UCT Shuttles prove helpful in technology trials

The university's on-campus bus infrastructure is proving to be a fertile testing ground for transport-related innovations with commercial potential, in the past, today and into the future.

A technology startup that was launched as a student project almost 15 years ago, the integrated mobility data platform WhereIsMyTransport not only had its roots at UCT where it was entered into a business plan competition, but it also saw the university's shuttle service play a major role in its inception. Today it is a success story that can inspire many a young business-minded inventor.

"WhereIsMyTransport began after one of the co-founders spent one day too many waiting for a delayed university shuttle, not knowing when it might show up. Quickly realising that missing public transport information was a problem bigger than one route, it turned into a journey that would reach far beyond campus," reads an excerpt from the company's website.

In 2019 the company secured funding of USD 1.85 million to expand its digital mapping of formal and informally run public transport networks in new, emerging economies.

> **We are looking forward to exploring a smart traffic monitoring system that can be deployed at a traffic intersection for long-term data collection.**

Earlier this year, UCT's shuttles were again instrumental in testing novel technology when they were fitted with a device to detect and analyse potholes, which are one of the most important issues in African road-networks. Potholes cause vehicle damage, accidents and, with time, accelerated degradation of the underlying road infrastructure. Better infrastructure management requires advanced data gathering.

The UCT trial validated a pothole detection, classification, and logging (PDCL) system envisaged by Sensorit.io, an autonomous automotive innovation company founded and headed by Aubrey Mnisi that uses IoT (internet of things) and AI (artificial intelligence), in collaboration with UCT's Radar Remote Sensing Group (RRSG). This system represents the initial step in Sensorit's modular approach to producing fully autonomous vehicles for African markets.

The Optical Oracle technology invented by Professor Amit Mishra of the Department of Electrical Engineering was what had sparked Mnisi's interest in running the trial.

The project, managed within UCT by Dr Stephen Paine, successfully delivered a number of unique, high-tech solutions to complex problems such as real-time processing of radar and high frame rate video data using a combination of hardware encoding and hardware accelerated machine learning techniques for machine vision.

The first prototype named Amehlo (meaning 'eyes' or 'vision' in isiXhosa) has been deployed on UCT Shuttles to great success. Francois Oosthuizen, Innovation Commercialisation Manager at RC&I, explains that the

tests where expanded from the initial focus on potholes to monitoring trees on the bus routes on request from UCT's Properties and Services Department, as these cause considerable damage to the fleet of buses.

Paine, a lecturer at the Department of Electrical Engineering lecturer who acted at Chief Technology Officer on the project, adds: "We are looking forward to the next stage of development, which includes looking for additional funding and exploring a smart traffic monitoring system that can be deployed at a traffic intersection for long-term data collection.

"The collaboration has also opened doors for students working on some of the research to enter industry with a running start."

Looking to the future, as UCT seeks greener solutions to campus requirements, there may be potential for the hydrogen fuel cell components (catalysts and membrane electrode assemblies) developed at HySA Catalysis to be trialled on the university's shuttle service. HySA Catalysis, hosted by the Department of Chemical Engineering and science council Mintek, is part of the Department of Science and Innovation's flagship Hydrogen South Africa project.

Find out more at **https://www.sensorit.io**



Students help to test UCT STI biomarker assay

Research done by Dr Jo-Ann Passmore and Dr Lindi Masson of the Division of Medical Virology, inter alia found that South African women are more likely to contract a certain type of vaginal inflammation, which could provide higher-risk conditions for HIV infection.

Using UCT's healthcare infrastructure in the form of access to patients, clinicians and healthcare workers at various clinic sites throughout Cape Town and its surrounding communities, the researchers were able to test biomarkers that have the potential to detect inflammatory vaginal infections.

The outcome of this study was the development of the Genital InFlammation Test (GIFT) - a lateral flow device that can detect both asymptomatic and symptomatic inflammatory vaginal infections. The device has been patented and a prototype developed, which will soon be trialled in partnership with UCT Student Wellness Services (SWS) on campus.

"We are going to recruit students from SWS for laboratory testing of the new GIFT device. Ethics is being submitted as we speak," says Passmore.

Future plans involve collaborating with on-campus clinics and student wellness services to trial similar research.

Find out more at **https://gift.org.za**

CASE STUDY

i2i Pointing bright minds in the right direction

i2i cohort members and RC&I team members attended weekly guest lectures by industry experts, here with Wayne Stocks from The University Technology Fund (second from left)

> This course reframed my thinking in terms of career goals, because it opened the avenue of commercialising research

RC&I timed the launch of its Idea to Impact (i2i) training programme with World Intellectual Property (IP) Day in April this year. It is already succeeding in its aim to support the university's innovators in science, technology, engineering and mathematics (STEM) on the exciting path leading from research to patenting and commercialisation.

"The course had been designed to give researchers and especially new postgraduate students insight into the process of protecting intellectual property (IP) and commercialising it, but more importantly for them to start thinking about the ultimate impact that their research could have in terms of a new product or service, during the early planning stages of a project," explains Dr Andrew Bailey, Senior Manager: Innovation.

The i2i programme for innovators has six modules that were presented in weekly sessions of a few hours and supplemented by an external guest speaker who provided some real world insight into the topic of the week. It covers: IP management, technology commercialisation, new product development, project management, business models, and funding strategies.

"Since the introduction of the course, we have had fantastic feedback, and are seeing several students show interest in creating spin-off companies," says programme leader Niall Naidoo, RC&I's New Venture Support Manager, who hosted the programme.

Personal Experiences

Four of the students from the inaugural i2i cohort were keen to share their thoughts on the concept and on how they benefited from it.

Ansuya Chetty

Ansuya Chetty, a masters student in Forensic Science, thoroughly enjoyed the content and the introduction to some major topics of business: "As scientific researchers, we are generally unaware of the collaborations possible between publications/studies and the commercial world. Through the overview of concepts that this course provided, I gained insight into potential topics to explore in the future."

As someone who had no prior business experience or formal knowledge, she says the course had enlightened her.

"I appreciated the interactive manner in which the course was presented and the fact that it did not significantly add to my workload in the form of extensive submissions or assessments." She also learned much from the in-person lectures by the guest speakers, where case studies were explored.

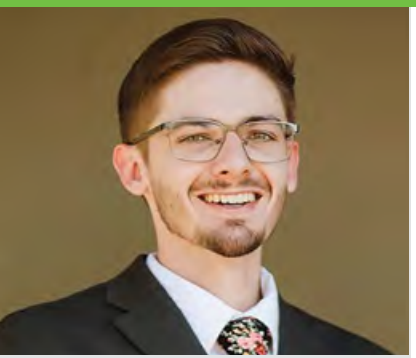
"This course reframed my thinking in terms of career goals, because it opened the avenue of commercialising research and will perhaps inspire future research that is more inclined to be commercialised."

The fundamentals derived from the course had broadened her approach to research. She said learning about the basics of product development may lead to such endeavours in the future.

Jonti Oehley

Jonti Oehley started with a master's degree in Biomedical Engineering in 2020, but this year upgraded his project and candidature to a PhD in Biomedical

> The i2i program is beneficial not just to those intending to commercialise, but to each and every student engaging in a project.



Joel Philpott

Maureen Etuket

Engineering. He is working on a novel medical device for the treatment of human blood products.

"The i2i programme has opened my eyes to the innovation ecosystem, the support available at UCT for technology commercialisation, and the individual journey it takes to commercialise research. When the time comes, I now have the knowledge to take the next step toward bringing my own postgraduate research project to market," he says.

Joel Philpott, another Biomedical Engineering student, adds: "The i2i course has broadened my understanding of commercialisation, enabling me to see how my research fits into the process and which additional processes and partnerships are required."

His research is focused on developing a device to diagnose and treat sleep apnea in an effort to reduce the number of undiagnosed cases and improve treatment accessibility.

Maureen Etuket is nearing completion of her Masters in Philosophy in Health Innovation. She co-directs an NGO, PUMZI Devices Uganda Ltd, that focuses on developing innovations for emergency care in low resource settings.

"I am very much interested in streamlining and making clear the innovation translation

i2i from idea to IMPACT

pathway for several innovators in Africa," she explains her decision to participate in the i2i programme. "I believe the i2i program is beneficial not just to those intending to commercialise, but to each and every student engaging in a project. This programme gives you fresh eyes, changes your perspective and points you in the right direction."

She believes that is the true essence of education is "Empowered to Empower!"

One of the speakers who shared their IP experience during the webinar was Dr Bevan Jones of the spin-off company Elemental Numerics (Pty) Ltd, which operates in the computational fluid dynamics field. He says it was essential to begin thinking about IP at an early stage.

His own process took 10 years, and the IP was now finally bringing in revenue. "In 2012 and 2013 I wasn't thinking about IP. But now that has become an important aspect of what the team does," he adds.

The i2i course will be presented at least once per year.

CASE STUDY

Integrating Innovation Management into coursework

Since its inception in 2014, the Medical Devices Design course, which forms part of the MSc in Biomedical Engineering, has included innovation management and assessment training as an integral component. RC&I plays a crucial role in guiding postgraduate students through the various processes, policies and available support systems to provide postgraduate students with experiential training that supplements their learning. This collaboration has resulted in a steady stream of invention disclosures and provides a pathway for other departments keen to increase the impact of research through commercialisation.

For as long as he can remember, Dr Sudesh Sivarasu, Director of UCT's Biomedical Engineering Research Centre (BmERC), has been curious about making things that work: "You can innovate and make things work in isolation, but when you want things to work together, it can be quite challenging."

This curiosity shaped his unique philosophy of design, which he calls Frugal Biodesign. "It's basically about fast-tracking innovations from point A to point B in resource-limited settings," Sivarasu explains. "The sooner you innovate and fail, the better it is for the innovation ecosystem."

> RC&I guides students through the basics of the IP policies, as well as the types of support systems UCT has in place. They learn how to conduct patentability searches, market assessments and about assessing commercialisation options, including through case studies.

Dr Sudesh Sivarasu, Director of UCT's Biomedical Engineering Research Centre (BmERC)

Marrying innovation, research and teaching

His Medical Devices Design course hinges on a close working relationship with local clinicians and their unmet needs in terms of clinical devices. "Each clinician comes up with their own list of problems form their own perspectives and experiences," Sivarasu points out. "So if you interview multiple clinicians, you will come across a trend of needs that can actually be solved locally."

Enrolled students are presented with a problem, a proposed solution, as well as the clinician they will be working with on developing this idea over the course of two semesters.

Understanding the Innovation Management process is key

The course first familiarises students with the innovation environment they will be working in. "We emphasise IP assessment, because understanding the process and the onus that rests on you as an innovator not to infringe on someone else's IP, is crucial," says Sivarasu.

RC&I guides students through the basics of the IP policies, as well as the types of support systems UCT has in place. They learn how to conduct patentability searches, market assessments and about assessing commercialisation options, including through case studies.

"Those students are then required to prepare an invention disclosure form, as well as a patentability search to see if they have a patentable invention, and a freedom to operate search to see if they are possibly infringing on existing IP," says Philip Hoekstra, Intellectual Property Manager at RC&I.

These invention disclosures are formally recorded by RC&I and the IP Management team thoroughly assess the submissions to identify those with IP and economic potentials. RC&I is also included as external examiners for the students' final oral exam.

Every year, since 2018, between five and seven disclosures have consistently resulted from the Medical Devices Design course – generating a big pipeline of UCT innovations complemented by RC&I support. This compares well to the Biopharming Research Bru (BRU), which have consistently disclosed between two and five inventions per year to RC&I over the last decade.

Despite this success, Sivarasu points out that there is no clear metric for measuring impact of innovation in university settings, unlike the quantifiable outcomes associated with research and teaching: "Innovation is not really a key performance indicator that is well defined in academia."

Saberi Marais, RC&I's Innovation Commercialisation Manager, explains the course's impact in the broader sense: "It's not only about lectures," he says. "It's about engagement and enriching the learning and discovery process as well, and taking a systems-view approach to innovation support and commercialisation at UCT.

"The process provides for interactive, applied learning outcomes; and aides our understanding of the researcher's approach and the market feedback. It is intended to build an evidence-supported invention pipeline, where the expectation of success is tailored to the project goals, objectives, complexity, and the intended impact that the researcher wants to make in society."

Positive outcomes

Success comes in various forms.

For example, not all disclosures from the course necessarily relates to patentable subject matter, says Hoekstra. In some instances, candidates opt to release their designs as open-source, which in some instances may be the appropriate strategy. Low-cost adaptations of known inventions may be another example of inventions where patenting is not ideal.

Even when discovering that a similar solution to your own concept already exists, Sivarasu says the process adds significant value: "You can be disappointed and move away from innovating, or you can use that as a confirmation that you are moving in the right direction."

A number of success stories have emerged from the Medical Devices Design Course.

Designed by Edmund Wessels, FlexiGyn by spin-off company Vas Med Tech is a flexible and mobile hysteroscope system consisting of a handheld control base, flexible rod, built-in CMOS camera, LED light source and a disposable sheath.

The flexible rod bends up to 180 degrees in four directions, and it integrates a smartphone or tablet for visualization. The device was designed with resource-scarce clinic environments in mind.

Edmund Wessels

"Understanding the relevant IP landscape is crucial for guiding your R&D process," says Wessels. "By learning about IP and performing a thorough IP search you're able to better understand where the gaps are, thereby ensuring your project is not only the correct solution but innovative as well."

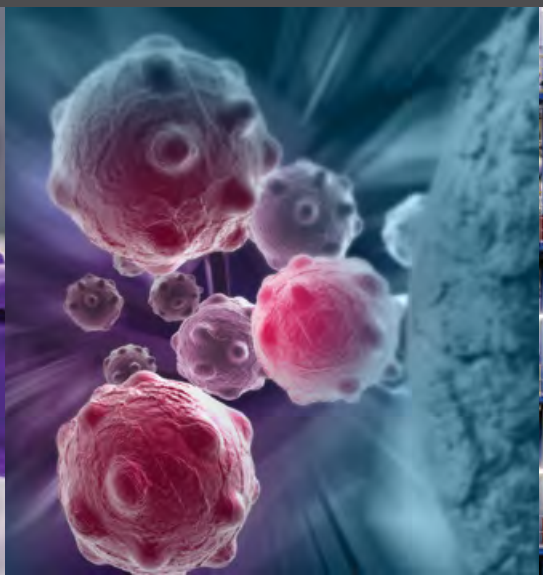
He adds that the IP training he received while pursuing his MSc in Biomedical Engineering laid a firm foundation for the work he's doing today.

"My project is built around the IP that was created in the R&D process," he says.

Marais concludes: "The course shows how a department can establish a robust innovation development process. This systems-based enables researchers and postgraduates to develop relevant technologies and innovations that are feasible to implement and commercialise in a way that capitalises on existing resources, retains skills and talent, and improves chances for success for new technologies."

New inventions

Contributing to South Africa's development challenges is one of UCT's strategic goals and the aim is to share knowledge that will benefit society. Many exciting new inventions have materialised from the UCT ecosystem since the onset of the global pandemic with particular relevance to industry, human health and animal health. Here, we provide a brief overview of these newly patented technologies.



Animal Health

Bovine Vaccines

Two different vaccines have been developed by Prof Anna-Lise Williamson's group in the Faculty of Health Sciences. One of these is a dual vaccine that can protect cattle against two crippling diseases in one formulation - Lumpy skin disease (LSD) and bovine ephemeral fever (BEF).

The fact that the geographical distribution of LSD and BEF overlap, notably in Africa, the Middle East and Asia, adds further significance to the innovative solution. Both diseases are seasonal, with the causative viruses being spread by biting insects.

Lumpy skin disease is caused by a poxvirus, lumpy skin disease virus (LSDV) and results in significant morbidity of cattle as well as economic losses due to damaged hides, decreased milk production, abortions and infertility. Bovine ephemeral fever, also known as three-day stiff-sickness, is caused by the rhabdovirus bovine ephemeral fever virus (BEFV) and causes a sudden onset of fever, associated with an inability to move or swallow. Pregnant cows often abort and bulls temporarily lose fertility. Milk production declines dramatically.

Currently these diseases are controlled by (separate) vaccines based on live attenuated virus or killed virus – in contrast, a vaccine such as the UCT one is preferred as it only has certain components of the viruses and cannot reconstitute into a virulent form of the virus. There is presently no dual vaccine against LSDV and BEFV available on the market. To date the research and development work has been funded by the Technology Innovation Agency and South African Research Chairs Initiative.

UCT will be partnering with a commercial partner to complete the scale-up and regulatory aspects of bringing the product to market in South Africa and beyond.

Inventors: Prof Anna-Lise Williamson, Institute of Infectious Disease and Molecular Medicine (IDM) in the Faculty of Health Sciences and SARChI Chair in Vaccinology; Dr Nicola Douglass, IDM; Henry Munyanduki, and Ruzaiq Omar, IDM.

The second vaccine, in early stage development, also relies on the LSDV backbone that was invented by the researchers some years back is designed to protect animals against LSDV and East Coast Fever (ECF), a severe bovine disease caused by the *Theileria parva* parasite.

The current vaccine on the market is unfavourable as cattle are inoculated with a lethal dose of live *T. parva* parasites and then treated with antibiotics. Besides numerous animals being required for the generation of *T. parva*, the method is time-consuming, laborious and expensive, a cold chain is required for the transport of parasites in liquid nitrogen, and vaccinated animals may become *T. parva* carriers.

This invention relates to the development of vaccines based on the *T. parva* sporozoite major surface antigen p67.

A lumpy skin disease virus (LSDV) recombinant was constructed and this LSDV vaccine has the potential to replace the current ECF vaccine, as it does not require cattle for generation, can be freeze-dried, will not result in *T. parva carriers* and may also provide protection against LSDV.

Inventors: Prof Anna-Lise Williamson, IDM; Dr Rosamund Chapman, Dr Leah Whittle and Dr Nicola Douglass of IDM; and Prof Edward Rybicki, Director of the Biopharming Research Unit (BRU) in the Science Faculty.

Human Health

Novel Cancer Drugs

Based in the Division of Chemical & Systems Biology, Prof Stefan Barth conducts multi-disciplinary research around the development of precision-medicine-type methods and systems for identification of differentially expressed targets for anticancer agents and/or identification of off-target effects of anticancer agents. These methods and systems allow for the identification of drugs to treat cancer, but do not have off-target effects.

Among the most notable differences between cancer cells and healthy cells is the overexpression in cancer cells of cell surface receptor (CSR) proteins, amongst others. By targeting CSRs that are overexpressed in cancer cells the new technology holds the potential to both improve treatment success rates and reduce off-target toxicity.

CSR proteins traverse the plasma membrane to provide sensory links between the extracellular environment and cytosolic signalling pathways. Besides being exposed on the external surfaces of cells, alterations in the signalling pathways within which many CSRs function are directly involved in oncogenesis making CSRs effective targets for immune-diagnosis or anticancer drugs and antibody-based anticancer therapies. The presence of large numbers of the targeted CSRs on healthy cells, however, is likely the primary cause of the dose-limiting toxic effects commonly associated with such drugs, so the ability to effectively address this issue thus provides a sought-after solution.

It is very early-stage technology but there is potential for it to be taken up by CURIT Biotech, Prof Barth's spin-off company.

Inventors: Prof Stefan Barth, Executive Director, Medical Biotechnology and Immunotherapy Unit at IDM and SARChI Chair in Cancer Biotechnology; and Ass Prof Darren Martin, Computational Biology Group at IDM; Dr Musalula Sinkala; and Dr Krupa Naran.

Rapid Detection of Microorganisms at Specie and Strain Level

Monitoring the presence of pathogenic microorganisms (such as m.TB) is essential for human health and safety. Current methods for bacterial identification include bacterial culture and colony counting (time consuming and laborious), ELISA (which suffers from poor sensitivity and low affinity of some antibodies to their target bacteria) and PCR (which is expensive and susceptible to cross-contamination).

All these methods can take days to yield results and where bacterial infection can rapidly lead to patient death, identification of the bacteria in a short space of time is critical. Examples include Salmonella, anthrax, E. coli and Listeria. Being able to diagnose tuberculosis (TB) at a strain level identifies drug resistant strains and ensures that patients are put on appropriate treatments, considerably improving effective community-based TB screening initiatives. Fast, strain-specific diagnosis of pathogenic microorganisms could therefore have a huge impact on human health and safety.

This invention is a nanosensor for rapid detection of bacteria (and other microorganisms) with the ability to distinguish microorganisms at both species level and strain level. It is based on the principles of Electrochemical-Surface Enhanced Raman Scattering (EC-SERS).

The SERS technique has in the past been explored for bacterial detection, but signal reproducibility has been difficult and one could not easily differentiate between different types of bacteria, let alone strains of the same bacteria.

In its current state, the EC-SERS technique is optimized for detection of TB mycobacteria in sputum and being refined for detection of the bacteria in urine.. Parasites, such as malaria, are also being investigated, potentially broadening the technology's application for healthcare scourge in Africa.

Inventors: Prof Jonathan Blackburn, Head of Chemical & Systems Biology and SARChI Chair in Applied Proteomics & Chemical Biology; and Dr Nicolette Hendricks-Leukes.

Melanoma Companion Diagnostic

Immune checkpoints prevent the immune system from attacking cells indiscriminately, but some cancers can protect themselves from attack by stimulating immune checkpoint targets.

Checkpoint inhibitors are medicines that block a cancer's ability to exploit these checkpoints such as the key ones: programmed cell death 1 (PD-1); and cytotoxic T-lymphocyte-associated antigen 4 (CTLA-4).

Around 54% of patients with advanced melanoma treated with a PD-1 inhibitor and approximately 41% of those treated with a CTLA-4 inhibitor benefit from the therapy.

If the two treatments are combined, 70% of patients receive a benefit, but this can be accompanied by the onset of high-grade 3 or 4 immune-related adverse events.

Unfortunately there is also a substantial subset of melanoma patients who do not respond to treatment at all.

By taking a sample from a patient, this invention predicts whether melanoma patients will or will not see a clinical benefit from an immune checkpoint inhibitor therapy.

The ability to predict treatment outcomes is really valuable, as it prevents ineffective and potentially toxic treatments

that are harmful to the patient, whilst also containing unnecessary health care expenditure, particular in the public healthcare sector.

The IP is co-owned with the Olivia Newton-John Cancer Research Institute (ONJCRI) in Australia.

Inventors: Prof Jonathan Blackburn, Head of Chemical & Systems Biology; and Muneerah Smith, postdoctoral scientist.

Production of Complex Viral Glycoproteins in Plants

Led by Dr Emmanuel Margolin from UCT's Biopharming Research Unit (BRU), this invention has increased the production of viral glycoproteins in plants, which are used as immunogens in vaccines, specifically focusing on emerging and pandemic viruses in Africa.

This invention combines chaperone expression and modification to increase glycan occupancy and reduce glycan truncation, while increasing the production of viral glycoproteins in plants.

By integrating previously known approaches with the UCT Chaperone expression technology, the researchers are now able to make complex viral glycoproteins in plants. The combination of chaperone co-expression with glyco-engineering opens the bottleneck in plants.

Although the previous approaches constitute prior art, the application of the approaches to viral glycoproteins and the combination of the approaches with the chaperone co-expression is unique and has commercial value well beyond what has been protected thus far.

Both chaperone technologies are licensed / in late stage license negotiation and will contribute to a rapidly developing biotech industry in South Africa

Inventors: Dr Emannuel Margolin, postdoctoral scientist; and Prof Edward Rybicki, Director of BRU.

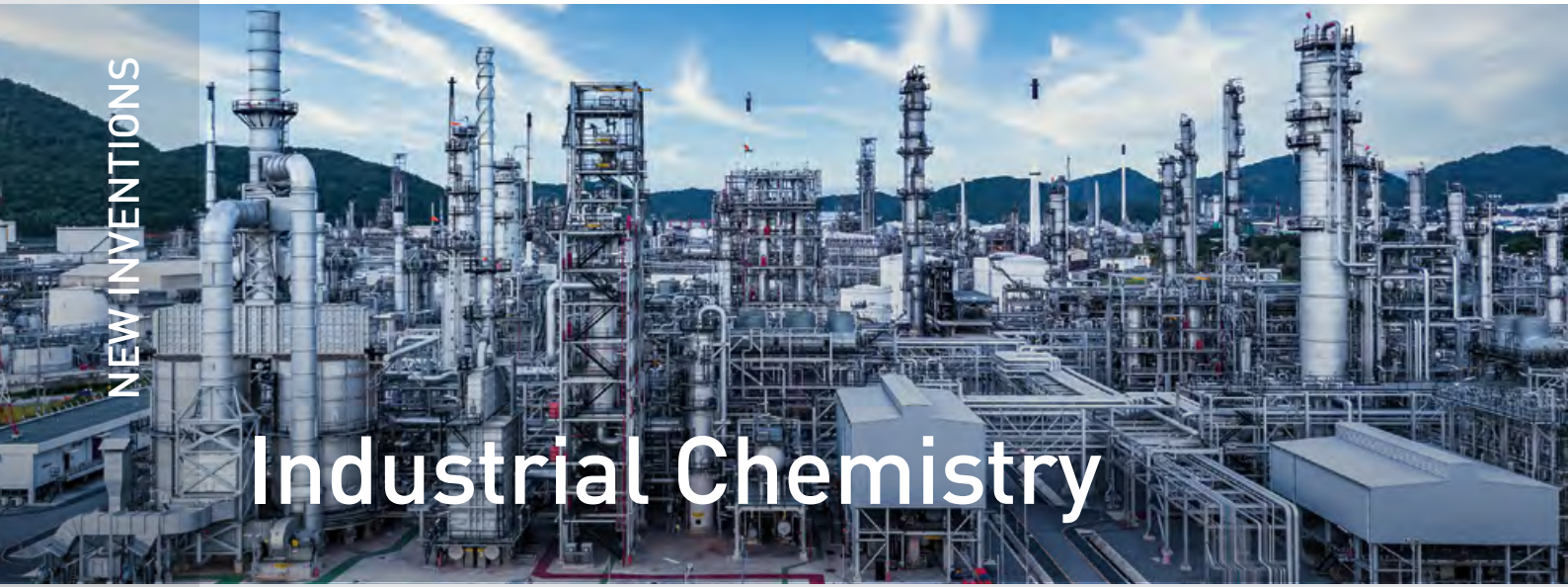
Enhanced Production of DNA Gene Therapies and Vaccines

The self-replicating nature of this DNA technology enables it to amplify gene expression and mitigate against the genetic silencing and biological losses that hinder the successful use of non-replicating DNA expression systems as gene therapies or vaccines.

It is an ideal candidate for use in complex protein expression and manufacturing applications where it dramatically improves production yields.

As an anti-cancer vaccine the self-replicating nature is also believed to activate innate cellular immunological and antiviral defence mechanisms that are key to eliciting an immune response in the body.

Inventors: Dr Warren de Moor, postdoctoral scientist in the Division of Medical Virology; Professor Anna-Lise Williamson of IDM; and Prof Edward Rybicki, Director of BRU.



Industrial Chemistry

Methane Oxidation

The main constituent of natural gas, biogas and landfill gas is methane, which is a valuable resource that may be used as feedstock for the chemical industry. For instance, methane can be converted into methanol, used as an industrial solvent to help create inks, resins, adhesives, and dyes, and formaldehyde, which is mainly used as a monomer or as reagent in the synthesis of fine chemicals.

The conversion of methane into products such as methanol and formaldehyde, proceeds currently via the synthesis gas route, in which methane is converted into a mixture of hydrogen and carbon oxides at temperatures as high as 1000°C, which are subsequently converted to methanol, and then to formaldehyde.

The thermal and environmental efficiency of the current process is only ca. 40% and "the direct selective oxidation of methane" yielding these products could improve this dramatically. This is, however, a challenging reaction as methane is rather inert, and the products are known to be more reactive.

The invention describes the catalytic, selective oxidation of methane yielding formaldehyde and its derivatives (with a selectivity of 70-90%) in a trickle bed reactor at industrially interesting conditions (200-250°C, and pressure of ca. 20-50 bar). Interestingly, the high selectivity is maintained upon increasing the conversion of methane opening up a route to apply this process on an industrial scale.

Inventors: Prof Eric van Steen, Department of Chemical Engineering and SARChI chair in Reaction Engineering; Junfeng Guo; and Malefane Letaba.

Empowered Catalyst Supports

There is an increasing global demand for green fuels and stable catalysts are an essential component of clean energy generation.

To achieve the required activity and selectivity, catalyst compositions commonly contain promoter elements at low concentrations. However, under harsh reaction conditions some of these promoters are reported to become unstable and mobile, resulting in a deterioration of catalyst performance.

The UCT inventors have generated proof-of-principle data for a novel catalyst support and the underlying process for locking-in promoters within its structure, which results in a more stable, active catalyst formulation.

This invention has potential impact on a number of clean energy processes providing new design parameters for catalyst developments with significant implications for knowledge and skills transfer.

Inventors: Assoc Prof Nico Fischer and Prof Michael Claey, both from the Department of Chemical Engineering

HySA Iridium Oxide Catalyst

The active oxygen evolution reaction (OER) catalyst, Iridium oxide (IrOx), is used in large quantities for electrolysers and in the durable proton exchange fuel cell technology. Currently, South Africa imports the catalyst and needs to contend with demand and global supply chain challenges.

A process developed by Dr Jessica Chamier, Chemical Engineering, will enable South Africa to become a very competitive supplier of the product. The attractiveness of this invention is that the single-step synthetic process is green, is performed under mild conditions in relatively cheap equipment with cheap and readily available primary materials. The only by-product is sodium hydroxide, which is useful in industry.

Knowledge and skills are being shared to move the work forward. Significant capacity is being developed around the production and supply chain of the IrOx product.

Inventor: Dr Jessica Chamier, Key Technology Specialist at the Institute for Catalysis Research, Department of Chemical Engineering.

EXCELLENCE ACKNOWLEDGED

International award for Emeritus Professor George Vicatos

An immense passion for his craft, blended with great empathy for humanity, were instrumental in inspiring emeritus Professor George Vicatos to create biomedical innovations that change lives while immersing himself in a brilliant career in orthopaedics over more than two decades. In recognition hereof, he has been honoured with an Innovation Award by the policy think tank and business do-tank ARGO-Brussels Hellenic Network for his innovative work in biomedical design.

Find out more at **https://www.attri.co.za** and **shorturl.at/ahlCF**

Although he had been awarded several times before, to him the ARGO Award was particularly special, he said. What made it especially noteworthy, was that it was an international award and would prove that South Africa has a niche of excellence, particularly Cape Town and UCT.

ARGO aims to cultivate and disseminate a positive message about Greece to its social and business network. Its annual awards recognise individuals from the Greek diaspora for their contribution to excellence in their profession in the fields of science, innovation, entrepreneurship, arts and culture, public affairs, sport, and philanthropy.

Vicatos' designs have helped innumerable patients and while the design of modular implants has had a major effect on the field of orthopaedics, his greatest professional fulfilment, according to him, has come from custom implants.

He was an inventor / co-inventor of tend different medical devices that were developed as part of his research whilst at UCT and postgraduate student projects that he supervised.

Although recently retired, Vicatos is still active in the spin-off company Attri Orthopaedics, that he created to commercialise the IP. Previous awards include the 2003 Innovation Fund Award, 2011 Popular Mechanics SA Inventor of the Year, and 2014 FutureTech Conference Cutting Edge Award.

“What made it especially noteworthy, was that it was an international award and would prove that South Africa has a niche of excellence, particularly Cape Town and UCT.”

Coveted SARIMA award for RC&I's Afo

Dr Wasiu 'Afo' Afolabi, Principal Intellectual Property (IP) Officer at RC&I was named the recipient of this year's award for Early Career Excellence in Innovation Management by the Southern African Research and Innovation Management Association (SARIMA).

This award recognises individuals with less than five years' experience in any of the core elements that make up an Innovation Management function.

SARIMA covers all member institutions (universities, university of technology, research councils, etc) from the SADC region. Nominations are reviewed and adjudicated by a panel of experts based on the nominees portfolio of evidence.

Afo's specific achievements include:

- Contributed to the review of UCT's multi-million rand Immuno-Theranostic IP portfolio, Invention Assessment Strategy and invention disclosure forms;
- Led the Entrepreneurship Ecosystem mapping exercise and contributed to the successful launch of MariHealth Solutions;
- Served as a member of the UCT internal panel for the Entrepreneurship Development in Higher Education (EDHE) student entrepreneurial competition and mentored the national winner;
- Provided continual support for the Emerging Researchers Programme at UCT;
- Received the AUTM scholarship for new tech transfer professionals from developing economies;
- Hosted learning visits for peers from Nigeria and Uganda, and provided support to tech transfer staff at University of Fort Hare and South African Nuclear Energy Corporation;
- Actively contributed to the community by delivering webinars, participating in regional forums and is a member of the 2022 SARIMA Conference committee.

"Personally, this is a humbling and rewarding experience. I don't see what I do as a job, rather a calling," says Afolabi.

> **Professionally, the validation indicates a step in the right direction. I am able to do more to support academic innovation and enterprise development. The award further confirms what needs to be done to accelerate knowledge/skills development and transfer within the corporate, academic, private and public sectors.**

The Department of Science & Innovation's National Intellectual Property Management Office (NIPMO) is gratefully acknowledged for the financial support that it provides to RC&I for the production of this brochure as well as a host of other technology transfer activities and support to establish new posts and develop the capacity of existing staff. NIPMO also provide UCT with an up to 50% rebate of our IP protection expenses.

RESEARCH CONTRACTS & INNOVATION

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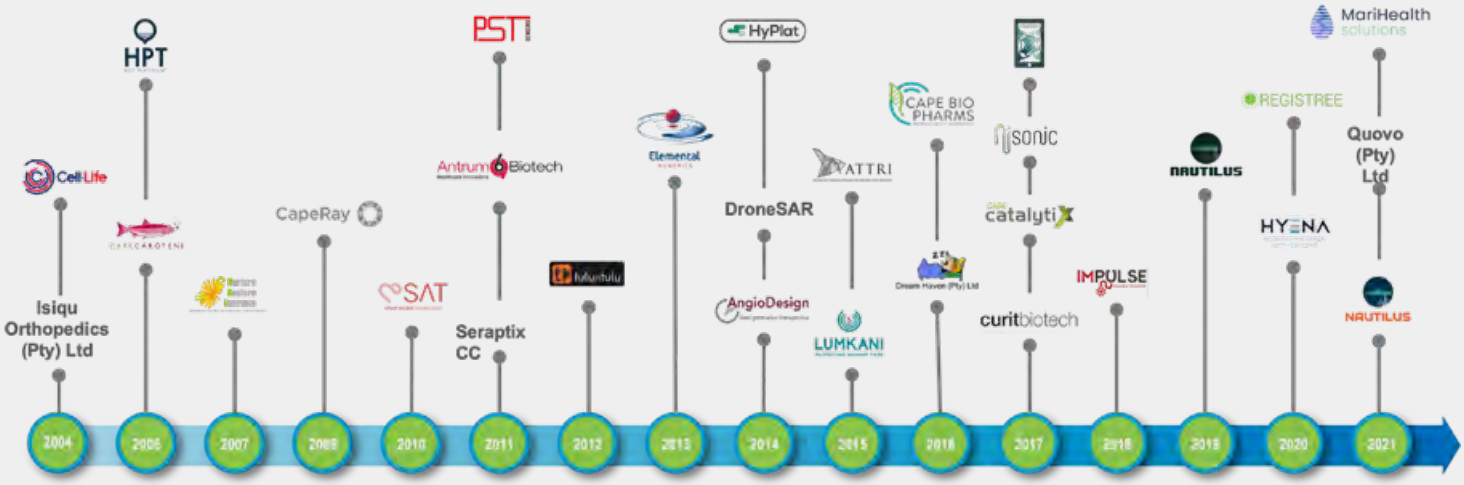

Since its launch in 2004, a steady stream of spin-off companies has emanated from UCT's Research Contracts and Innovation, many of which the university holds equity in.

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