



# Industry, innovation and infrastructure

**SDG 9:** Build resilient infrastructure, promote sustainable industrialisation and foster innovation



*Image by SKA South Africa.*



# Innovation, infrastructure and industrialisation: the cornerstones to economic health

The United Nations' 2030 Agenda for Sustainable Development aims to transform our world through a set of 17 goals. Sustainable development goals (SDGs) 8 and 9 could be considered prerequisites – the means, as Adam Szirmai put it, to achieve the other goals. Adequate infrastructure, together with industrialisation (which is an indirect effect of infrastructure) and creativity (innovation), are the cornerstones for economic competitiveness, and therefore closely connected to the achievement of political, social and economic goals. But innovation reaches far beyond these two goals, argues **Piet Barnard**.

The Global Competiveness Report 2015/2016, which provides an overview of the competitiveness performance of 140 economies, ranked South Africa 49<sup>th</sup> overall, putting the country in the top 35% of all countries. South Africa is ranked 36<sup>th</sup> on innovation and business sophistication, 50<sup>th</sup> on technological readiness, 59<sup>th</sup> on infrastructure (mainly due to a low rating for electricity supply – 116<sup>th</sup>), 12<sup>th</sup> on financial-market development and 38<sup>th</sup> on goods-market efficiency, to name but a few. Based on this, one would consider South Africa to be well positioned in terms of SDG 9, and as a result able to address the other goals.

UCT's Research Strategy 2015 to 2025 commits the institution to contribute, through its research and innovation, to (*inter alia*) the better health of our citizens and those of our continent, the elimination of poverty, and creating the conditions for a meaningful life. The strategy furthermore pledges that the institution "will serve both South Africa and the rest of our continent by contributing to its ability to innovate in a world where new and radical thinking ensures the competitive edge".

Innovation is an integral part of our strategy; as a result, an innovation working group was established to help in building an innovation culture. The working group does not limit innovation to those inventions that lead to patents and the generation of income, but has defined innovation as "the creation and successful implementation of new ideas and inventions that make a real difference through the generation of tangible outcomes with social and/or financial value".

This definition seeks to include the notion of social innovation. The university's research strategy speaks to many of the SDGs, and is addressing those through various initiatives; many of these include significant innovation. For instance, SDG 3 (Good health and well-being), which is a bold commitment to end the epidemics of AIDS, TB, malaria and other communicable diseases, is at the core of the research of the Institute of Infectious Disease and Molecular Medicine (IDM), and UCT holds numerous patents related to these diseases.

However, UCT is not unique in these commitments and initiatives. Many of the other South African universities have similar initiatives, and are also undertaking similar, credible research. The question is then: why does the Global Competitive Report rate South Africa 128<sup>th</sup> on health and 120<sup>th</sup> on quality of education? These rankings place South Africa behind neighbouring countries such as Botswana, Zambia and Zimbabwe. What are we doing wrong? What are we as a research community, in collaboration with government and the private sector, going to do to address these problems?

Resolving these two important matters will require innovative thinking, commitment and collaboration. We need to get this right; if we don't, many of the goals – despite our current efforts – will remain just that: goals. ○

*Piet Barnard is director of Research, Contacts and Innovation.*

# Africa's first d-school trains postgrads to solve complex real-world challenges

The newly-established Hasso Plattner Institute of Design thinking (HPI d-school) at UCT is one of only three HPI d-schools in the world. “The school’s overall objective is to promote design thinking as an enabler of innovation and new outcomes that can meet the needs of users in complex socio-political and economic contexts,” says Richard Perez, founding director of the UCT HPI d-school.


Design-thinking training’s basic tenets are collaboration, human-centredness, creative thinking and learning through doing. The d-school’s flagship offering is transdisciplinary training in design-led innovation to postgraduate students registered at any faculty at UCT.

Design-led innovation is seen as both a career and an entrepreneurial competency. “It’s a way of thinking that provides students with tools and a process – and ultimately, a mindset – that equips them to work together to create solutions to real-world challenges,” says Perez.

The focus of the training is experiential learning, and students work in multidisciplinary teams, closely mentored by coaches, in a customised studio space. During the training, students apply design-thinking tools and techniques to develop solutions for real-world challenges provided by strategic project partners.

Among these partners have been one of South Africa’s major financial institutions, a department of a local municipality and a start-up. The partners receive the benefit of user insights, a library of ideas and a tested prototype of one of the ideas.

The HPI d-school at UCT also offers other training programmes, including courses for executives, undergraduates, young entrepreneurs, and organisations and institutions.

The other HPI d-schools are at Stanford University in the USA (est. 2005) and Potsdam University in Germany (est. 2007). The school is supported with funding, IP and academic support by the Hasso Plattner Trust. 



# Powering Africa's first hydrogen fuel-cell aircraft

An award-winning aircraft – a large, fixed-wing, unmanned aerial vehicle (UAV) – has been designed to carry out long-range surveys and environmental research. It will be powered using miniaturised hydrogen fuel cells that were designed, prototyped and trialled by HySA/Catalysis. It is an excellent example of the centre's mission to help transform South Africa's economy into one that manufactures from its wealth of raw materials, rather than just supplying them for others to exploit.



**HySA/Catalysis** – co-hosted by UCT and Mintek – is one of three government-funded centres of competence, and is tasked with developing South Africa’s contribution to global hydrogen and fuel cell technology. The centre collaborated with Professor Arnaud Malan and his team from the Department of Mechanical Engineering and **FlyH2 Aerospace**, the company that will be producing the UAV, which became a licensee of the patented fuel cell technology developed by HySA/Catalysis.

Speaking after the UAV recently won first prize at the **Avi awards** held by the Council for Scientific and Industrial Research in Pretoria, co-founder of FlyH2 Aerospace Mark van Wyk described the aircraft as the first of its kind to be designed and built in Africa. Better yet, the use of hydrogen fuel cells means that the aircraft will operate with zero emissions. “The system emissions are completely toxicant-free,” van Wyk explains. “In the future, our company wishes to develop the technology further, to a level where it can also power manned aircraft. Both Boeing and Airbus have undertaken significant research into hydrogen fuel cells. This could be the future of green aviation.”

The UAV, however, is just one application of fuel cell technology. When it comes to HySA/Catalysis, the centre’s aims are far broader. Dr Sharon Blair, director of HySA/Catalysis, explains that the centre hopes to assist in transforming South Africa’s economy from a resource-based economy – as a supplier of raw materials – to a knowledge-based economy, developing, manufacturing and exporting value-added products. Right now, South Africa sells platinum as a raw metal, and exports it,” explains Blair. “Other countries then upgrade that platinum to create products that we buy back – at a much higher price.” Her goal, at HySA/Catalysis, is to make sure South Africa develops the manufacturing capabilities to begin to climb that value chain, starting at the platinum refinery.

At this point, she believes, it is critical that South Africa focuses on the early stages of the platinum value chain. “What we are trying to do here is develop the intellectual property in South Africa based on platinum components, so that we have more control over where the materials and components are manufactured, and can build a sustainable industry,” she says.

As the UAV demonstrates, fuel cells are a very promising clean power source, with the potential to replace our current ‘dirty’ internal combustion

engines. A key component of these cells is platinum, which is converted into a catalyst – the first step on the platinum fuel cell value chain. The catalyst is a powder, which is then painted onto a membrane – the second step up the value chain to the membrane electrode assembly (MEA). The manufacture of these two simple first steps would have significant effects on the country’s economy.

According to **BCC Research** in 2013, at current fuel-cell market growth rates, the catalyst and ink market in 2017 will grow to \$265 million, and the MEA market to \$1.2 billion. This reflects about 9.5 times the original value of the raw platinum.

We have an opportunity to participate in this market globally, thus increasing the value of goods currently exported from South Africa.

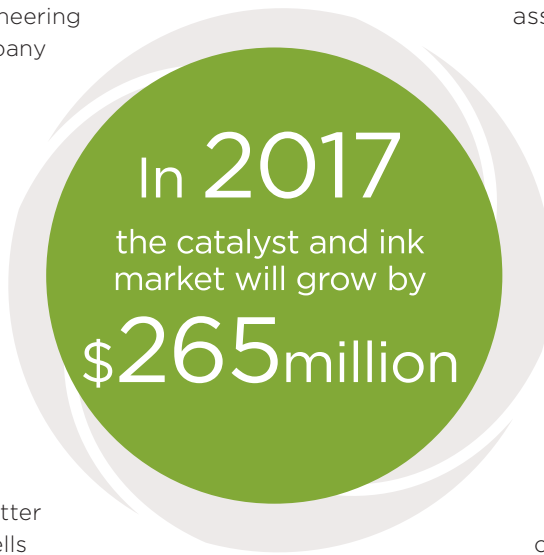
As it stands, says Blair, HySA/Catalysis has developed a family of platinum catalysts on a par with international products, and they are just beginning to sell these. The next step will be the membrane electrode assembly, and they are working with their first customers now to meet their needs.

The centre is also developing advanced fuel-cell components based on stainless steel and other materials that can be manufactured in South Africa. The promise of these technologies is starting to attract large global automotive fuel cell companies as partners, but the intellectual property will remain in South Africa.

“So while we know what components we can sell today,” she says, “we are also developing components for 10 years down the line.”

The focus on the early stages of the value chain is just one avenue of HySA/Catalysis’ strategy. The centre partners with foreign fuel-cell companies and introduces them to local companies that can participate in delivering components, all the way up through distribution to the end customer. These foreign partners agree to incorporate local technology into their products once it meets their needs. In 2015, Powercell Sweden installed their low-temperature fuel-cell system on a Vodacom mobile tower, using local company Powertech Systems Integrators. Powercell is also one of HySA/Catalysis’ potential MEA customers. HySA/Catalysis wants to see benefits for multiple players along the supply chain, and it is already well on its way to doing so.

*By Natalie Simon and Ambre Nicolson. Image of Alpha supplied by FlyH2.*



# Producing ‘T’-shaped graduates yields living gold



Since mining can affect all 17 sustainable development goals (SDGs) to varying degrees – both positively and negatively – it is poised to play an extraordinary role in achieving them, writes Dee Bradshaw.

To do so, it needs to go through a metamorphosis; from the current negative perception of mining as an environmental and socially compromising extractives sector, to that of a cornerstone of sustainable development, through supplying critical resources while generating significant multiplier effects across the broader economy.

For this to happen, the SDGs must be more than aspirational targets: they need to be ingrained in the culture and behaviour of all participants, and the appropriate technology needs to be developed and incorporated.

Minerals and metals fundamentally underpin the functioning of every aspect of modern society. In addition to the obvious contribution of smart devices and their connectivity, there is no means of generating energy without metals, whether using renewables or fossil fuels; and no agricultural, construction or manufacturing industry is possible. Even our health and well-being is dependent on the minerals and metals in daily use. As the incoming fourth industrial revolution accelerates and takes hold with increased technology, automation and connectivity, this need is expected to increase exponentially.

However, as part of the extractives sector, the mining industry globally faces multiple, multifaceted internal and external challenges. These include technical challenges, such as declining grades and difficult locations; financial and economic challenges, with cost escalations, delays and rising operating costs, and lower productivity; and social and environmental challenges, which include heightened competition for water, energy and land, growing scrutiny of the industry’s social and environmental performance, and an increasingly complex policy and regulatory environment. Although the sector makes a significant contribution to the macro, social and political economy, its long association with environmental disasters, human rights violations, unequal wealth distribution

and community conflicts tarnishes its reputation and threatens its licence to operate (LTO).

The key goal related to mining is SDG 9, with its aim being to build resilient infrastructure, promote sustainable industrialisation and foster innovation; but it is underpinned by many of the others. The Minerals to Metals Signature Theme is committed to doing just that, through the focused activities of innovative, integrated research, stakeholder engagement and postgraduate education. The research philosophy has a systemic, holistic view of mineral beneficiation that is underpinned by a fundamental understanding of the processes and development of the technologies supporting it. This includes our belief in the circular economy, and in working with urban as well as geological deposits. Our innovative technical methods and processes incorporate sustainability principles, building on the strong technical expertise of the research groupings in the Department of Chemical Engineering.

Our focus is on the interface between technology, society and regulation, as demonstrated by the collaboration between the two DST/NRF SARChI Chairs: Mineral Beneficiation and Mineral Law in Africa. We produce ‘T’-shaped graduates who can operate from an integrated systems perspective, but also with a strong understanding of and competence in their discipline; they will be comfortable working outside their core discipline in multidisciplinary teams, as well as being mentally agile – able to identify and respond to non-intuitive opportunities that will provide step changes and lead the way in building a platform for sustainability through minerals and metals. They will join the community of practice equipped to lead, shape and sustain our world, developing our true legacy – living gold! 

Minerals and metals fundamentally underpin the functioning of every aspect of modern society.

*Professor Dee Bradshaw is the DST/NRF SARChI Chair in Mineral Beneficiation, and director of the Minerals to Metals Initiative.*

# Mapping mining to the SDGs: a preliminary atlas

Although mining can affect all the United Nations (UN) sustainable development goals (SDGs) either positively or negatively, it has an extraordinary potential to contribute to their achievement. UCT has participated in a global project: an atlas that outlines key focus areas for the mining industry within each of the 17 SDGs.

Mining can mobilise vast physical, technological and financial resources. It also serves as a catalyst to promote investment and innovation, and to stimulate the creation of jobs that will contribute towards the achievement of the SDGs and the broader 2030 agenda.


In order to help all stakeholders in the international mining sector navigate how to contribute towards these SDGs, *Mapping Mining to the sustainable development goals: a preliminary atlas* was conceived as a joint project and developed by the Columbia Centre on Sustainable Investment (CCSI), the UN Sustainable Development Solutions Network (SDSN), the United Nations Development Programme (UNDP) and the World Economic Forum (WEF). A draft was issued for public consultation in January 2016.

Having identified the opportunity, UCT has launched an initiative to assess the extent to which mining companies already contribute towards the SDG objectives, in both quantitative and qualitative terms. It will also identify ways in which the sector should adapt and improve, by implementing new operating procedures or methods, and embed the SDGs more effectively in governance, management systems, organisational culture and disclosure.

“The programme aims to inculcate this culture into the future leaders in the industry, by building the principles into every aspect of their engineering and business education, in both undergraduate and postgraduate course work and assignments,” says Adjunct Professor Mike Solomon.

Professor Dee Bradshaw, DST/NRF SARCHI Chair in Mineral Beneficiation, initiated workshops hosted at UCT to discuss the mining atlas, and submitted their contribution and additions to the atlas. “Our major contribution to the document,” she says,

“was the inclusion of the recognition of the role that universities and learning institutions have as a source of ideas and opportunities, and to convene and coordinate education, research and professional development that address mining and the SDGs.”

Solomon and Bradshaw met the partners in New York City in September 2015, and presented their work on operationalising the SDGs for further engagement and discussion of next steps. 



# UCT team smashes eight-year water rocket world altitude record

A team from the Industrial Computational Fluid Dynamics (InCFD) research group has successfully broken the longstanding Class A water rocket world altitude record by a massive 33%, achieving a height of 830m.

“It is the first world record in rocketry set by a South African university that I am aware of,” says Professor Arnaud Malan, DST/NRF SARCHI Chair in Industrial Computational Fluid Dynamics, who led the research group. He adds that it is “definitely the first appearance South Africa has made on the international water rocket scene.”

The record was formally ratified on 7 October 2015 after international peer review by the Water Rocket Achievement World Record Association. The previous record of 623m, set in 2007 by US Water Rockets, has had no equal for eight years.

Says Malan: “The water rocket competition is very exciting and environmentally friendly, as it uses only water and air to reach incredible speeds. The competition is truly multidisciplinary, and requires pushing the boundaries of state-of-the-art technology in areas ranging from mechanical design and lean manufacture to computer-based mathematical modelling. It is like the Olympics of water rocketry: clearly, we are now the undisputed best of the best.”

Water rocketry provides a challenging postgraduate training platform, says Malan. The technologies it requires have several applications, including ultra-light pressure vessels for transport, catapulting cabling and ropes for construction and even novel thrusters for space applications.

As with most academic (rather than commercial) projects, this was done on a shoestring budget: the rocket was built from off the-shelf-components and using standard tooling.


The result was a featherweight, record-breaking rocket that is 2.68m tall, yet weighs less than 1.5kg, including a flight computer, on-board camera, parachute and parachute deployment system.

The rocket produced 550kg of thrust – enough to lift a small car off the ground – and blasted off to 550km/h in under 0.5 seconds (it could cross a rugby field in three-quarters of a second). The team made extensive and creative use of carbon fibre materials, due to their amazing strength.

The record was the end of a long journey for the research group – driven by Stuart Swan and Malan, with assistance from Donovan Changfoot and William Liw Tat Man, all based at the Department of Mechanical Engineering. The successful ascent came after two failed attempts and numerous innovations and refinements, in a process that tested the team’s perseverance.

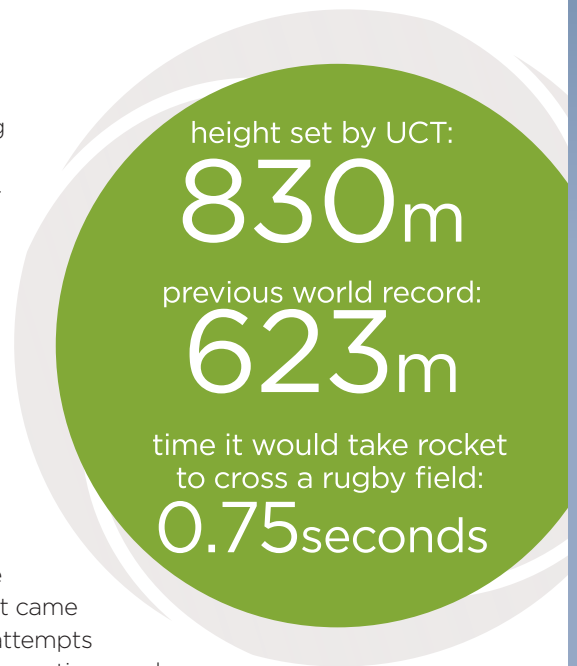
The first attempt – in November 2013 – failed because the carbon-fibre rocket vessel was leaking air severely. To resolve this, the team devised a creative and cost-effective sealing solution (for which a patent is currently being applied).

A second attempt, which sported a significantly improved launch pad – important for the large forces expected – was aborted when the rocket failed to lift off. A number of innovations, ranging from pressure-vessel manufacture to a radical fail-safe parachute deployment system, led to the development of Ascension III.

On 26 August 2015, the team headed out to Elandsberg Farms in the Western Cape. The first flight achieved a height of 835m – 217m higher than the previous record. To secure the world record, a second launch had to be completed within two hours of the first. With 10 minutes to spare, the second launch took place and reached an altitude of 825m, setting a new world record of 830m. 

*Story by Carolyn Newton.*

[Watch video here](#)





# Using FM radio broadcasts to make air traffic control safer for Africa

Africa has the highest accident rate per flying hour in the world, and the lack of regional air traffic is crippling development in Africa. In the meantime, FM radio broadcasting is experiencing a meteoric rise, serving as the dominant mass medium in Africa.

These two facts may seem unrelated, but to members of the Commensal Radar Project, the proliferation of FM radio waves can in fact provide affordable and safe air traffic control in Africa and the developing world.

## Developing an alternative system

Very few African countries other than South Africa have radar systems installed at their airports. As it stands, pilots flying across the continent have to rely on a manual system to avoid aircraft collisions. "The pilots know who is taking off from where, and when, and they talk over the radio to coordinate their routes," says Professor Michael Inggs of the Department of Electrical Engineering and the Radar Remote Sensing Group.

He stresses that this is a situation that cannot continue: "As the continent develops, we will see a massive growth in air traffic," he says. But a radar system can cost around \$10 million – prohibitively expensive for many developing countries.

Inggs and his team at the Commensal Radar Project, a collaboration between UCT, the Council for Scientific and Industrial Research (CSIR) and Peralex Electronics, have developed an alternative radar system – using FM transmissions, and a number of receivers spread out across many hundreds of kilometres and connected by cell phone links – to track the location of aircraft, with an accuracy of 100 metres or closer. This, says Inggs, is more than adequate for air traffic control safety standards. Work is currently underway to commercialise this technology.

## Building the Commensal Radar


The Commensal Radar Project started around the year 2000. Inggs read about a researcher in Europe who was using television signals to track aircraft, and began to investigate a similar solution for Africa. "For technical reasons, I found using FM more effective than television signals," he says. The aircraft reflects the FM signal, which

can be picked up through a receiver. At the same time, as the aircraft moves through the signal, a phenomenon called the doppler shift occurs. This is a change in the frequency of a wave, such as a sound wave or a radio wave, depending on the speed of an object and the position of an observer. The simplest example is an ambulance siren: when the ambulance is coming towards you, the pitch of the siren is different from when it is moving away from you.

"The term 'commensal' is biological," explains Inggs. "It refers to a system where two organisms share a relationship in which one may benefit from the existence of the other, but the organisms don't affect one another." This perfectly describes the relationship between the receivers of the Commensal Radar Project and the FM radio transmitters. The project's receivers use the FM transmission to track aircraft, but the transmitters themselves are not affected by this – they simply keep transmitting pop music and talk shows to listeners.

## Exceptional problem solvers

The project faced a number of challenges, most of which were solved by a sequence of exceptional PhD students grappling with the applied mathematics problems faced in the project – including Craig Tong, who worked on developing the software to receive and process the signals. Francois Maasdorp resolved the ambiguity over pinpointing and tracking a single aircraft when there are other aircraft on an ellipse around it (This mathematical challenge was based on the work of a PhD student from Chad, Roaldje Nadjiasngar.). The final step was a demonstration, tracking South African Airways planes coming into Cape Town.

It is for this work that the Commensal Radar Project was awarded Gold at the annual AVI (Africa Aviation Innovation) Awards in late 2015. The project has also just been awarded the **IEEE Harry Rowed Mimno Award** for clear dissemination of technical material. 

*By Natalie Simon. Image by Hansueli Krapf, Wikimedia Commons.*

# Big developments in big data: astronomy and data science in Africa

The Square Kilometre Array (SKA) project will produce data at a rate comparable to that of global internet traffic. But if we don't have the infrastructure and skills to deal with it, the data will go offshore; Africa will lose this stellar science and business opportunity. Three South African universities have formed a new institute to ensure that Africa will be able to meet this challenge, with benefits for the continent that go far beyond astronomy.

"The data revolution is set to be a globally transformative phenomenon - if you don't ride the wave, you're going to be flooded by it," says Professor Russ Taylor, director of the recently launched Inter-University Institute for Data-Intensive Astronomy (IDIA). IDIA, a partnership initiative between the University of Cape Town (UCT), the University of the Western Cape (UWC) and North-West University (NWU), is a flagship project to respond to the immense big-data challenge of the [Square Kilometre Array \(SKA\)](#) - a global endeavour to build the world's largest radio telescope - in South Africa.

The institute aims to ensure South Africa is ready not only to ride the big-data wave, but to drive it, says Taylor.

Big data refers to the large, complex data sets – created and collected through technology – that are set to affect every aspect of life. But the SKA poses a particular challenge: tasked to collect data from deep space-dating back to the very start of the universe 13 billion years ago, the SKA will collect around 1.5 exabytes of data a year – that is, roughly one and a half billion gigabytes.

South Africa, as co-host (with Australia) of the SKA, is thus uniquely placed to lead the global response to big data – an opportunity we dare not miss.

### Preparing for data sharing

It is this precise situation the IDIA seeks to avoid. “At IDIA, we are essentially laying the groundwork – in terms of both infrastructure and human resources – to be ready when the SKA turns,” says Taylor.

The real challenge, explains Taylor, is not just to build a big pipe to manage the data, but to store it in a way that enables the global collaboration required for a project of this magnitude.

“Teams in Africa, Europe, Asia, Australia and North America all want to work together on this data. So the issue is not only how to store and manage the data, but how to enable collaboration on a big data set that nobody can actually have on their desktop,” he says. “What this means, in practice, is that we need to build new cyber-infrastructure platforms.”

The first of these platforms is the Africa big data Research Cloud (ARC), the first phase of which is housed in UCT’s cloud-based data centre. The ARC gives researchers the ability to develop collaborative research environments in which they can share data, computational capabilities and other tools, unimpeded by the restrictions of time and space. It is envisioned to grow to include the eight African partner countries on SKA, and a number of SKA partners in Europe.

### Developing data scientists

IDIA is also focused on building the skills needed for the new digital world of big data. “Big data will fundamentally change the way we do science,” says Taylor. The world is witnessing a global shortage of data

scientists – a job description that didn’t even exist just a decade or two ago. IDIA is set to remedy this shortage: firstly, through the recruitment of graduate students and postdoctoral researchers to work on the data challenges; and secondly, by putting in place programmes to train people in this new specialisation. From 2017, UCT will offer a master’s degree in data science, while Sol Plaatje University in the Northern Cape recently created a dedicated undergraduate degree in data science.

### The sexiest job of the 21st century

The *Harvard Business Review* has described “data scientist” as “the sexiest job of the 21st century”. This skill set is sought after in just about every industry the world over, from tourism to marketing to astrophysics. A study by McKinsey projects that by 2018, the United States will face a 50% gap between supply and demand for individuals with strong data-analysis expertise. By offering this data-science speciality, South African universities seek to fill not only a niche created by the SKA, but a global skills shortage.

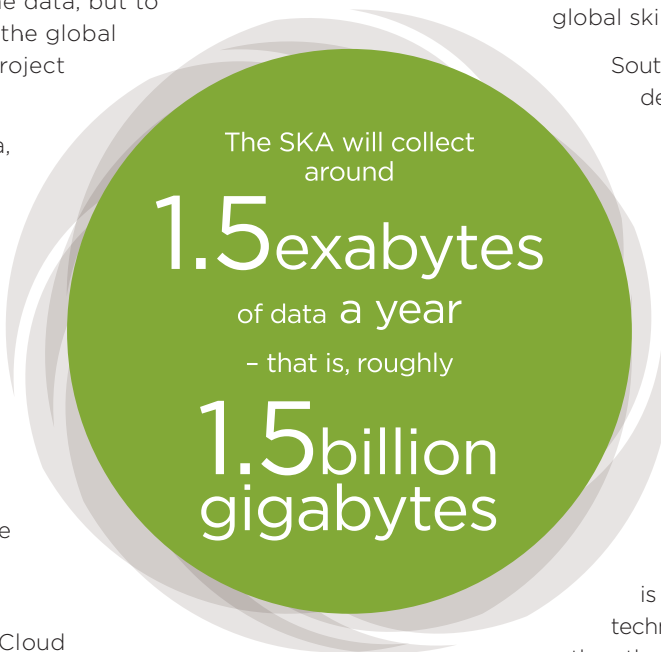
South Africa stands to gain a great deal from taking full advantage of the SKA and the big-data challenge. A large part of the rationale for this country’s comprehensive investment in the SKA project is the benefits that will accrue as a result of the project, which extend far beyond just the astronomical.

“There are three elements of development in the SKA,” says Taylor. “The first is the development of the technology to build the project; then there is that of the scientific outcomes, and the ownership of these outcomes; and finally, the development of skills that comes from the requirement to utilise such sophisticated equipment.”

Such skills are primarily in information and communication technologies, and investment in these skills is a long-term investment, he explains. For South Africa to reap the rewards, we need to engage fully.

“At the core of it,” says Taylor, “IDIA is about building the capacity to ensure that we in Africa are ready to engage in and benefit from one of humanity’s most ambitious science projects to date – taking place here, within our borders.”

*By Natalie Simon. Image by SKA South Africa.*



# The role of space technology in meeting SDG targets

**The link between space technologies and the sustainable development goals (SDGs) may not be obvious, but space tech may provide the key to achieving a number of these goals, writes Peter Martinez.**

Space technologies today touch the daily lives of ordinary citizens around the globe – in fact, they are so embedded in our information society that most people are unaware of how reliant we have become on them. It goes far beyond the satellite pictures shown on the daily TV weather forecast. Cell-phone networks, the internet, financial institutions, electrical power utilities, street- and traffic-light networks, aviation and maritime navigation are just some of the utilities and services that rely on data from space systems.

Remote sensing satellites provide global coverage of the Earth, and allow us to detect and study changes in the Earth's climate, atmosphere and oceans. Earth-observation satellites support the development and negotiation of treaties for environmental protection, and can be used to monitor compliance with and document violations of environmental and security-related treaties.

Global-navigation satellite systems support synchronisation of terrestrial networked infrastructures, improve aviation and maritime navigation and safety, enable more precise cartography, and support search-and-rescue operations.

## No longer a luxury

Satellite technology is also extensively used in early-warning, monitoring, assessment, response and recovery operations for natural and humanitarian disasters, and has been used to save many thousands of lives.

Because of high entry barriers, space technology has been seen as a luxury in the past, and the development-aid sector has tended to shy away from it as being too 'high-tech' for developing countries. However, these technologies can now be seamlessly integrated with familiar terrestrial technologies, such as GPS on smartphones.

Far from being a luxury for developing nations, therefore, space technology is, in fact, an essential contributor to meeting the SDGs. It provides the modern infrastructure of the information society, and today's satellites, ground stations and data centres provide the basic infrastructure to acquire, receive and process space-derived data that is turned into useful information for citizens – be it a weather forecast for a fisher, or a market forecast for a farmer.

This is as important in the 21<sup>st</sup> century as the development of roads, bridges and harbours were to the development of industrialised economies in the 20<sup>th</sup> century.

In January 2016, the African heads of state adopted the new African Space Policy and Strategy, which provides a vision for harnessing space science and technology for the development of Africa. Against this backdrop, a group of postgraduates at the UCT SpaceLab has been examining ways in which space technologies can be harnessed to meet the SDGs in Africa.

They identified food security as a theme that could be used to support the achievement of several SDGs, and have proposed the development of a Space-based Agricultural Information and Monitoring System for Africa (SAIMSA). This envisages an open-source cell-phone/tablet application that will empower farmers with critical information on climate and farm conditions, allowing them to make informed decisions that will increase their yield, and develop contingency plans for extreme weather events. There will also be a link in the application to financial markets, which will allow farmers to access financial information to help them with commodities trading. ○

*Professor Peter Martinez is founder and head of the UCT SpaceLab, in the Department of Electrical Engineering.*

