SERA Research Collaboration

2000 – 2012

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CSIR
our future through science

SOUTHERN EDUCATION & RESEARCH ALLIANCE
Research Collaboration

2000 – 2012

FOREWORD

*Prof Cheryl de la Rey,
UP Vice- Chancellor and
Principal*

*Dr Sibusiso Sibisi, CSIR
CEO*

The University of Pretoria and the CSIR have a long history of collaboration. The Southern Education and Research Alliance (SERA) – formalised in 2000 to effectively respond to global prospects of research resulting from the growing knowledge economy – has enriched the partnership. The geographic proximity and established links provided the opportunity to pioneer the strong alliance.

We have ensured that our research and innovation activities are relevant to South Africa's development needs. In so doing, we have consistently aligned our research, innovation and knowledge transfer activities and strategic priorities. These are rooted in the country's policies, national priorities and strategies as developed throughout the years.

This joint UP/CSIR publication captures several achievements of this journey of our collaboration – many of which have and will continue to contribute to South Africa's socio-economic development and global competitiveness. We look forward to further success and the pursuit of exciting new areas of collaboration.

OVERVIEW

Prof Stephanie Burton, UP Vice-Principal Research and Post-graduate Education

Dr Rachel Chikwamba, CSIR Group Executive, Strategic Alliances and Communication

The SERA partnership commenced in 2000 through a Memorandum of Understanding which has been implemented in the context of the partners' respective mandates and strategic priorities, and which broadly addresses the need to further strengthen research and development and human capital development.

The specific initiatives that have been undertaken through this partnership are aligned with the CSIR Research Impact Areas, Research Priority Areas and Institutional Research Themes of UP. The quality of the work has been greatly enhanced by UP and CSIR's complementary infrastructure, capabilities and focus on research at different stages of the innovation value chain.

Some of the work done by the teams is leading to improvements in energy efficiency; mining safety; health and nutrition; efficiency and effectiveness of research, as well as increased capacity in these and other areas.

Through SERA and other collaborative activities that have taken place outside this alliance, we have furthered the shared commitment to human capital development. This has been achieved through training courses, joint student supervision, and the establishment of research chairs/ centres, through external funding. The collaborative activities over this period have resulted in joint publications and patents. In addition, a number of researchers have been appointed as either CSIR fellows or extraordinary professors at UP.

As we look ahead, the CSIR and UP aim to achieve greater impact in the areas that are aligned with the UP Institutional Research Themes and the CSIR Research Impact Areas, in line with both organisational mandates and national imperatives.

RESEARCH

Collaborative projects implemented

98

Joint publications resulting from supervised and joint research (2005–2012)

474

Patents developed

8

HUMAN CAPITAL

$E = mc^2$

CSIR staff and students studying at UP (2011–2012)

214

CSIR staff who graduated at UP (2011–2012)

46

CSIR researchers lecturing/ supervising students (2011–2012)

87

UP staff appointed to CSIR research advisory panels

4

CSIR staff who hold extraordinary appointments at UP (2011–2012)

11

NRF-rated science and engineering researchers (2013)

250

Contents

THE JOURNEY

Eunice Ndeke, CSIR

The journey of SERA has been guided by a vision of creating world class competence and capacity through attracting and retaining the best people; developing and applying knowledge to all aspects of the science, engineering and technology value chain; supporting sustainable development and economic growth, in South Africa and in the Southern Africa region; collaborating to reinforce and support the objectives of the National System of Innovation; creating a supportive research environment; and, competing globally in science and technology.

The objectives of SERA have been achieved through task teams collaborating in several focus areas:

SERA focus areas

- Digital@SERA (ICT)
- eResearch enablement
- Food, health and nutrition
- Process integration for clean coal technologies
- Gene technologies
- Water
- Sustainable rural development
- Flammability testing
- Building indicators
- Remote sensing
- Plant propagation and cultivation technologies

The joint and multidisciplinary research activities have harnessed UP and CSIR expertise in science, engineering, and technology. Research and funding partners have enhanced the partnership between CSIR and UP and have contributed to realising the vision of the alliance.

Research activities include developing a novel bio-artificial liver support system for cases of acute liver failure; improving research efficiency and effectiveness of researchers engaged in natural products research; improving the safety and quality of traditional African food; investigating the use of emerging technologies in gas sensing and wireless technology to improve mine safety; improving inter-institutional cooperation in the field of biotechnology; and optimising the integrated gasification combined cycle technology.

The number of collaborative projects, which have been implemented through SERA and other UP/CSIR bilateral collaborations, has increased substantially since 2003 and has resulted in 8 jointly registered patents.

Eight registered patents: In-shell pasteurisation of eggs, bio-reactor device and method of cultivating live cells, edible coating for preserving food, treatment of cancer, management of HIV, automated culturing of cells, bulking of soft tissue, and preparation of starch nanoparticles using starch pasting.

Joint publications (2005-2012)

The projects have contributed to the production of joint research outputs. Between 2005 and 2012, UP and CSIR researchers jointly produced 220 peer-reviewed journal articles, 239 reviewed conference papers, and 15 book chapters.
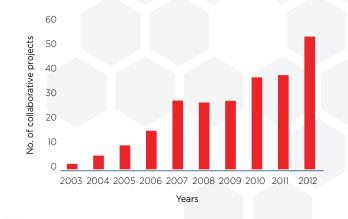
The development of new capacity, which has been supported by CSIR bursary programmes, has been an integral part of the collaboration since the establishment of the alliance.

Over the years, CSIR staff members have lectured and supervised students at UP, and some have been awarded honorary appointments by the university.

The pool of talent that is available at UP and the CSIR includes researchers with national and international recognition.

Recently there has been a refocusing of research priorities to reflect new national and global challenges. Researchers in the SERA partnership will now develop long-term initiatives within the themes of animal health and production, big research data and high-level computing, energy, environment and sustainability, poverty reduction, health, and water.

Collaborative projects (2003-2012)

NRF-rated researchers (science and engineering), April 2013
Internationally acclaimed researchers: UP (54); CSIR (9)
Leading international researchers: UP (6); CSIR (1)
Established researchers: UP (130); CSIR (8)
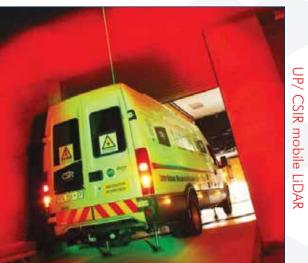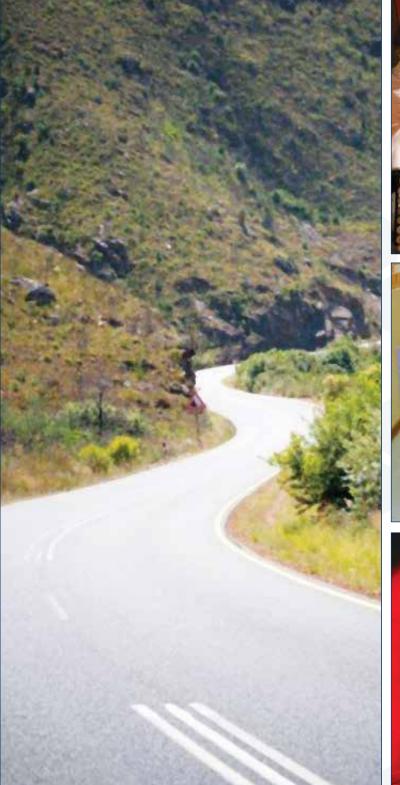Promising young researchers: UP (30); CSIR (10)

Major Milestones

Patent: Bio-reactor ⊙ — 2001
Bio-artificial liver support system

Main research partners:
Academic Medical Centre (Amsterdam),
Onderstepoort Biomedical Research Centre

— 2005
⊙ **Patent and licensing: In-shell pasteurisation of eggs**

Food, health and nutrition

Main research partners: ARC, MRC, TUT,
Moi University, UCLA

UP Water Institute ⊙ — 2007
Water

Main research partners: Georgia Tech, WRC

— 2008
⊙ **Collaboration through SABINA network**
African Centre for Gene Technologies

Main research partners: Universities of Wits,
Malawi, Namibia, Dar es Salaam

First results of the Mobile LiDAR system ⊙ — 2009
Remote Sensing

Main research partners: Universities of Wits,
UKZN, Addis Ababa, Reunion

— 2011
⊙ **VRE Model**
eResearch enablement

Main research partners: East Africa Tea
Research Foundation, Universities of Wits,
Malawi, Namibia, Dar es Salaam

Joint ICT Research Chairs (at UP & UKZN) ⊙ — 2012
Digital@SERA

Main research partner: UKZN

In-shell pasteurisation of eggs

UP/CSIR BALSS prototype

UP/ CSIR mobile LiDAR

Health and Nutrition
Bio-artificial Liver Support System

Dr Sean Moolman, CSIR I Gerrie Mostert, UP

Background

The bio-artificial liver support system (BALSS) project started in 1998. The interest, which initially came from UP, was in the use of systems for the treatment of acute liver failure, a condition with a higher than 80% mortality rate, and whose only treatment option was a liver transplant. Due to a shortage of liver donors, many patients die while on the waiting list.

At that time, some of the latest research on bio-artificial livers focused on encapsulation of (typically porcine) liver cells in hydrogel beads. UP requested the CSIR polymers group to assist with encapsulation of liver cells in such hydrogel beads. By the year 2000, it had become evident that the hydrogel beads had serious limitations, including low functional density and oxygen supply issues, and hence seemed unlikely to produce the desired outcome.

Response

The team developed a new bio-artificial liver concept. This involved using only the plasma from blood and circulating it through an external bioreactor containing porcine or other liver cells. The plasma contains all the required toxins for treatment and nutrients for liver cell function, but not the red blood cells, white blood cells and platelets. It, therefore, has a more limited immune response compared to whole blood in contact with foreign / exogenous liver cells.

The key invention was the addition of a synthetic oxygen carrier, a perfluorocarbon emulsion, in order to provide oxygen for the liver cells. This is required, since the plasma does not contain red blood cells that normally deliver oxygen. In this manner, both the immune response and oxygen delivery considerations (the two key considerations in BALSS bioreactor design) were addressed in a single system.

Progress

The team advanced the technology significantly from 2000 to 2007. Two versions of the system were produced for large animal (pig) studies. A substantial number of studies were done on pigs with an ischemic liver failure model, at Onderstepoort Biomedical Research Centre. The final outcome of the animal studies was that the system with cells performed better than an empty system without cells. It also performed better than the ischemic liver failure control, but this difference was not statistically significant, thus requiring extensive additional trials to confirm the difference.

The team also realised that the ischemic liver model is very aggressive and toxic, and perhaps less suited for testing the UP/CSIR BALSS. In order to better elucidate the synthetic functions of the UP/CSIR BALSS, the team did not include a toxin clearance component such as an activated carbon column at that stage. It was concluded that animal studies might need to be repeated using an anhepatic liver failure model, which allows stronger and clearer indication of the synthetic function of a BALSS.

Due to the very large cost of repeating the animal studies, the need to do such studies in Good Laboratory Practice conditions, and the progress of competing BALS systems internationally, it was decided to consider partnering with an international BALSS developer who had made more progress in obtaining regulatory approval, and to test the function of their systems with the addition of the UP/CSIR synthetic oxygen carrier. This would fast-track the system's development and the SERA partners would remain candidates for developing the first commercial BALSS in the world.

The CSIR/UP system was reviewed in 2007 by two international experts, one of whom had worked for a company that had

taken a bio-artificial liver support system to Phase 2 human clinical trials. The review supported a partnering strategy for the project.

The CSIR/UP team subsequently started discussions with Arbios, a US company that took over the assets of Circe Biomedical, a company that went to Phase 3 human clinical studies with its version of a BALSS.

Arbios agreed in principle to do a comparative study using its bioreactor, with and without the UP/CSIR synthetic oxygen carrier. However, at that stage Arbios declared itself insolvent, and was acquired by another company, Hepalife. The new owners defocused from further developing a BALSS and hence this option was abandoned.

Further unsuccessful efforts to engage with alternative potential partners were made. The lack of accessible commercialisation routes, and the departure of some of the key researchers at UP led to the termination of the project.

Apart from producing publications and training students, the project resulted in a number of spin-off projects and patents. It also led to the establishment of a hepatology research laboratory at UP, as well as the establishment of a strong emulsion manufacturing and characterisation capability at the CSIR, which still forms the core of several of this group's projects and its intellectual property portfolio.
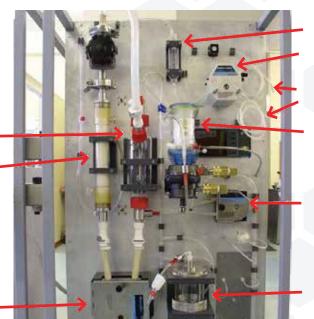
Future work

The Academic Medical Centre in Amsterdam is still investigating the use of the UP/CSIR perfluorocarbon emulsion system in kidney and liver preservation (for transplant applications). There is a possibility that some components of the project could be revived in collaboration with Katholieke University of Leuven in Belgium.

Outputs
Patents – 2
Peer-reviewed journal articles - 6
Students trained - PhD (2); Masters (2)

Plasma reservoir

Plasma exchange pump

Connections to plasma separator

Oxygenator

Bioreactor circulation pump

Bioreactor

Plasma & PFOB reservoir

Membrane separator

Plasma-PFOB circulation pump

Improving traditional South African food products using a combination of traditional and new technologies

Dr Nomusa Dlamini, CSIR | Prof Elna Buys, UP

Background

The Food Sciences group at the CSIR has worked with small scale and large industrial food companies to develop products and processes using innovative technologies. It is currently collaborating with several African and European partners in an EU funded project, AFTER (African Food Tradition REvisited by Research).

The EU-AFTER project focuses on using traditional knowledge and expertise together with modern technology, to produce African traditional fermented food products of a consistent quality which are more marketable and have a long shelf life. As part of the AFTER project, a CSIR staff member is studying for a PhD on investigating the interaction of mycotoxins with lactic acid bacteria during fermentation at UP. The project seeks to establish how lactic acid fermentation can potentially improve the safety of fermented cereal products, by investigating the interaction of lactic acid bacteria with mycotoxins. The CSIR is also working with a local SMME which is processing a cereal-based fermented non-alcoholic beverage.

Cereals are at risk of infection by mycotoxigenic fungi and their related mycotoxins. Mycotoxins are stable, low molecular weight secondary fungal metabolites, which may not be detected by antigens and initially produce no obvious symptoms. Mycotoxins affect both human and animal health and can be hepatotoxic, carcinogenic and teratogenic. In most rural areas throughout Africa, people depend on subsistence farming which can produce foods that also carry a high risk of mycotoxins.

This study may provide insight into how traditional fermentation processes may be affecting food safety. Many methods have been investigated in the detoxification of mycotoxins including physical methods of separation, irradiation, chemicals, adsorption and cooking temperatures. A new method of detoxification, where some mycotoxins have a natural affinity to bind to microorganisms, has recently been discovered.

Response

CSIR and UP are collaborating to improve fermentation processes and quality of a traditional sorghum fermented beverage. The determination of microbiological quality and characterisation of the fermenting microorganisms has started, and preliminary samples have been analysed. The traditional product has been evaluated for nutritional quality, and will further be evaluated for shelf life. Methods to extend shelf life, such as the use of improved packaging technologies, and control of critical steps that have been identified will be incorporated into the processing.

With regard to investigating the potential interactions of lactic acid bacteria with mycotoxins, the project proposes to focus on the microbiological characterisation of the fermented cereal products, and utilisation of lactic acid bacteria isolated from the products, to investigate their potential in mycotoxin control. The binding interaction between the lactic acid bacteria and fumonisin will be investigated, along with the stability and toxicity of the resulting bound complex.

A postgraduate student will perform research relating to the improvement of the product. UP is responsible for the microbiology aspects of the project. The CSIR provides co-supervision and also provides insight on understanding the overall quality of the fermented product, including physical, chemical and nutritional changes taking place. The CSIR together with other partners will also assist the SMME to identify and implement improved processes.

Future work

Future collaboration will be expanded by increasing the number of joint projects, starting with one on indigenous leafy vegetables. UP will evaluate the sensory properties of products developed using selected indigenous leafy vegetables. The indigenous leafy vegetables have been characterised at the CSIR, and found to have high levels of nutrients, such as minerals and pro-vitamin A carotenoid, beta carotene. Some of these leafy vegetables are potential sources of health benefitting phytochemicals such as the flavonoid rutin and carotenoid lutein.

Outputs
Students trained – PhD (1); MSc (1)

This study *may provide insight into how* **traditional fermentation processes** *may be* **affecting food safety.**

African Centre for Gene Technologies

Dr John Becker, CSIR/UP joint appointment

Background

The African Centre for Gene Technologies (ACGT) was formed to promote inter-institutional collaboration in the field of advanced biotechnology. The initiative has since grown to include the Agricultural Research Council (ARC), and the Universities of Johannesburg (UJ) and the Witwatersrand (Wits). The ACGT plays an integrating role with particular emphasis on genetics, genomics and its subsets.

The ACGT will continue to demonstrate its relevance by establishing new large collaborative initiatives and raising funds for collaborative research and development projects in order to create a network of excellence in the region. It will achieve this by growing the capacity of the Centre and leveraging the substantial expertise that exists among its members. The following examples highlight the SERA collaboration in biotechnology under the auspices of the ACGT.

ACGT microarray and bioinformatics facilities

The ACGT microarray facility started operating in 2002, providing a core service and infrastructure for researchers wishing to utilise microarrays in their work. The facility has since advanced in providing training and expertise associated with the technology to users in South Africa and the region. Numerous projects have been implemented in conjunction with the facility, and research outputs have been published in peer-reviewed journals and other reports. Thousands of slides have been scanned and printed at the facility. The microarray facility attracted funding from BioPAD between 2005 and 2007.

The ACGT Bioinformatics and Computational Biology Unit, which is part of the UP Department of Biochemistry, was established in 2003. It hosted the ACGT node of the National Bioinformatics Network (NBN), which included the CSIR, University of Limpopo and ARC Onderstepoort from 2003 until the dissolution of the NBN in 2009. The Unit trains postgraduate students, hosts workshops in the field of bioinformatics, and provides access to state-of-the-art computational infrastructure. It supports many research projects within UP and the CSIR, as well as in the wider ACGT community. Data generated have been included in numerous publications.

South African Malaria Initiative

The South African Malaria Initiative (SAMI) was established in 2006 with funding from the Department of Science and Technology (DST), to facilitate an integrated programme of malaria research and capacity development in South Africa. It includes the CSIR, UP and several other South African universities. SAMI was administered by the ACGT before moving to BioPAD; the latter has since been incorporated into Technology Innovation Agency (TIA). The initiative has been instrumental in bringing together malaria researchers in South Africa. It has also established effective networks with overseas partners.

SABINA and POL-SABINA

The ACGT was instrumental in establishing SABINA (Southern African Biochemistry and Informatics for Natural Products) in 2008. The network comprises the CSIR, UP and Wits University in South Africa; the University of Namibia, University of Dar es Salaam in Tanzania, as well as the Tea Research Foundation of Central Africa which is based in Malawi. The programme has trained a new generation of

researchers for some African universities, focusing on natural products research. The Centre has attracted funding from the European Union, African and the Caribbean and Pacific group of states (EU-ACP) to bolster SABINA through the Policy and Support Actions (POL-SABINA) programme which is coordinated by UP. The funding has helped the SABINA programme to provide training, mobility for researchers and students, as well as develop policy on natural products research.

Bioscience researcher database

The ACGT hosts a database of scientists involved in advanced biotechnology research in the region. The database contains details of research interests and programmes and associated equipment. The database, which has the details of more than 200 advanced biotechnology researchers in the region, is accessible by all partner institutions, and allows searches by several fields for complementary expertise or equipment.

Regional fora and workshops

The ACGT has established two regional scientific fora - the Regional Plant Biotechnology Forum and the Synthetic Biology Forum - and successfully hosted a number of events including numerous workshops in the fields of biotechnology and bioinformatics.

"There is not only a scarcity of skills in biotech, but also a lack of equipment. However, what we have found is that there are pockets of excellence within the partnership. So, for example, we may have very good expertise in genomics here and a great proteomics facility there and by identifying and bringing them together under ACGT we immediately have the best skills and equipment." - **Dr John Becker.**

Virtual research environment for the SABINA network

Dr Martie van Deventer, CSIR I Dr Heila Pienaar, UP

Background

The overall objective of the project was to create a supporting infrastructure and collaboration platform for the SABINA network, whose partners are located in Malawi, Tanzania, Namibia and South Africa.

The infrastructure and collaboration platform was intended to enhance the efficiency and effectiveness of researchers - masters and doctoral students and their supervisors - engaged in natural products research at partner organisations. The initiative is associated with capacity building initiatives to support information age researchers. The activity also needed to create an appropriate environment to facilitate the translation of research outputs into products that will benefit society, the economy and consumers.

The specific objective for the SERA partners was to develop an advanced web-based knowledge management system for sharing natural products research information.

Response

In order to achieve its objective, the project team created a Virtual Research Environment (VRE*) infrastructure in three distinct phases.

During the first phase, the team provided all scientists in the network with equal access to relevant content – such as databases, accredited open access journals, project publications, information on funding opportunities, proposal templates, collections of references, bookmarks and other useful resources relevant to the partnership. Further, the WITS ICT department was contracted to oversee and guide platform development and maintenance. This responsibility was transferred to the UP Library during the third phase of the project.

The second phase enabled participants to upload their own documents and research data. Each student, and their supervisor, was given a secure project space with access to research project-related data and information. The VRE was linked to an initiative to develop the skills to encourage scientists to systematically curate and preserve scientific output. It was anticipated that the introduction of these activities would improve researcher efficiency and develop the discipline required to participate in international virtual teams associated with large research projects.

The third phase emphasised understanding of the VRE participant. Three aspects, namely the factors that encouraged or discouraged participation, training needs and the specific qualities of the VRE facilitator were investigated/reviewed and documented. The specific aim at this stage was to enable effective access to, and use of, the VRE infrastructure by current and future partners, including those outside the SABINA network.

Progress

All three phases were completed successfully. While the VRE is still an entry level platform, it is stable and the majority of the SABINA students have adapted to the discipline of uploading content. It is therefore possible to now expand the VRE to include the work of students and staff

"This cross-disciplinary approach that necessitates online collaboration highlights the value of relationships such as the CSIR-UP alliance. While it is not always easy to achieve, it is invaluable. I work in a Science Council and special library environments and I can see that our interaction with UP adds great value and a perspective that many of my colleagues at other institutions simply don't have access to." – **Dr Martie van Deventer.**

who did not directly benefit from the Pol-SABINA grant.

Outputs

The most important output of the project is the open source collaboration platform, which can be replicated in other environments. The platform is a reliable store of project-specific documentation and research content. In addition, considerable experience has been gained in the development of collaboration platforms as well as on the facilitation of online communities.

The students have gained experience in participating in online work communities. All of their project information is in electronic format and it is possible to harvest and curate such content where appropriate.

Future work

A proposal for an integrated database has been submitted to a potential funder. The research team is also planning to further develop training content – making use of the VRE's integrated e-Learning functionality. The SABINA network has agreed to manage the VRE and therefore during 2013/ 2014, transfer of skills and infrastructure to staff appointed by the network will take place. Finally, as part of an extensive hand-over exercise between WITS and the UP Library ICT support units, the project team reviewed the lessons that have been learnt. This will be shared through publications and conference presentations.

The focus area leaders have overseen the evolution of the collaboration from traditional library services to the more contemporary and multi-faceted concept of eResearch support. They have made a major contribution to growing awareness and understanding of the services required to enable eResearch. "Most people didn't understand what we were trying to do. But it's becoming clearer now. But that wasn't always the case."- **Dr Heila Pienaar.**

ICT

Wireless gas sensing in mines

John Isaac, CSIR I Prof Gerhard Hancke, UP

Background

South Africa ranks high in many important minerals globally; it is also by far the richest *in situ* mineral resource holder in the world. The country's mining sector still has tremendous opportunity for growth. Most of the top global mining companies operate in the country. Therefore, key technologies employed in South Africa, if successful, would readily have a global market.

The miner-fatality rate in South African underground mines averages between 10 and 15 people each month. Apart from the human cost, this has a huge economic impact on the mines due to regulatory work stoppages after a fatality. Approximately 70% of South African mines are classified as fiery mines. The number of flammable gas reports and accidents is increasing steadily for both gold and platinum mines.

There is currently no real-time monitoring of gas in South African hard rock mines (other than coal mines). Gas is monitored occasionally for specific gases by handheld devices. There is, therefore, a perceived niche application of real-time wireless gas sensing technology in hard rock mines (gold and platinum).

Response

The Wireless gas sensing in mines (Wigami) project investigated whether emerging technologies in the fields of gas sensing and wireless communication can be used in mines. The objective of the project was to investigate how to adapt novel gas sensing technology, developed by Selskapet for Industriell og Teknisk Forskning (SINTEF) for the oil and gas sector, to the mining sector in South Africa. The expected outcome was a proven concept which can be developed further by industrial partners.

The consortium conducted a study to determine the wireless gas sensing requirements and practice with respect to gas sensing and wireless communications in underground mines. Parameters for gas sensing as well as wireless communications needed to be determined through experiments. Patented gas sensing technology from SINTEF (through its subsidiary company GasSecure) was tested in an underground mine. This required the designing of test procedures, as well as a number of visits to perform the tests underground.

Reliable and efficient communication networks are needed in underground mines. However, to design an optimal wireless communication network in these mines, an accurate channel model with realistic computational load is needed to predict the channel characteristics such as path loss and signal delay spread. Channel characterisation experiments were conducted underground to determine propagation characteristics at various frequencies and also to determine protocol

efficacy of Wireless Highway Addressable Remote Transducer (HART) and ISA 100.11a standards.

The experiments indicated that in a comparison between 433 MHz, 868 MHz and 2.4 GHz frequencies, there were significant multi-path effects, though 868 MHz had generally better overall propagation characteristics in line-of-sight and non line-of-sight conditions between two points. Under the test conditions there was no significant difference between Wireless HART and ISA 100.11a and either could be used in a gas sensor network underground.

Future work

The project was completed in 2013. The Norwegian embassy in Pretoria has indicated that it would likely support a second phase focusing on possible commercialisation. A subsequent 3-year phase to integrate the gas monitoring with other sensing systems may be required.

Outputs
Students trained – 1 MEng
Peer-reviewed conference paper - 1
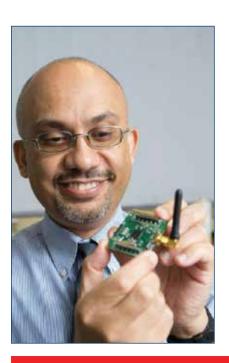
*There is, therefore, a **perceived niche application** of real-time **wireless gas sensing** technology in **hard rock mines.***

Advanced sensor networks

John Isaac, CSIR I Prof Gerhard Hancke, UP

Background

Advanced sensor networks (ASN) is the multidisciplinary field that pertains to the sensors and actuators that allow information, communication and technology (ICT) systems to sense and control the natural or built environment, either autonomously or in cooperation with human systems. ASN applications are usually domain specific, e.g. monitoring the condition of electricity or water infrastructure.

ASN research and development (R&D) in South Africa is too fragmented and sub-critical to realise significant socio-economic benefits. To address this, a collaboration centre, initially called ASN South Africa (ASNSA) was to be established by UP and the CSIR. This centre should provide coordination of R&D on advanced sensor networks across institutions and provide the critical mass of multidisciplinary skills needed to perform ASN contract R&D for industry, and create ASN products that could be commercialised locally.

Response

Two ASN research groups were formed - ASN@Meraka and ASN@UP – as a first step to effect this collaboration. To create critical mass and specialisation, the ASN partners helped with the development of National Research Foundation South African Research Chairs Initiative (NRF SARChI) proposals for research chairs to be co-hosted with the CSIR. Two were awarded in February 2012 - one on ASN at the UP, and the second on Intelligent Real-Time Power Systems (IRTPS) at the University of Kwa-Zulu Natal. The ASN chair is a generic anchor chair which will provide research leadership for ASNSA, and bring together capabilities in computer science and engineering at UP, in order to strengthen the ASNSA research programme. The IRTPS chair will provide specialised focus and competence relating to computational intelligence in ASNs for the Smart Grid.

The partners have been working to contribute to strategy and policy, such as the DST ICT R&D and Innovation Road Map; the TIA minerals and processing sector strategy; and, the South African Smart Grid initiative to develop a national smart grid strategy. "We are quite positive about the SERA initiative. Without it, our involvement at a national level would not have been so effective." - **John Isaac.**

In order to get the strategic alignment and long-term national funding for the ASNSA collaboration, the partners worked with the project team responsible for the development of the ICT Research Development and Innovation (RDI) Roadmap at the DST.

Progress

Neither chair is currently occupied, but efforts to identify suitable international candidates continue.

The National ICT RDI Roadmap has been approved by Cabinet. It explicitly recognises collaboration between institutions through research centres and research chairs.

The CSIR team needs to implement a key component (home-sense gateway) of a Green Fund project funded by the Department of Environmental Affairs. This is related to the smart grid work that the UP and CSIR plan to undertake.

Progress has also been made in human capital development through the training of students at UP and their co-supervison by CSIR reseachers.

Future work

It is anticipated that funding to support ASNSA, and to build critical mass in smart green infrastructure, will be available through the ICT RDI Roadmap starting in 2014.

The immediate priority is to establish ASNSA. ASNSA will work in smart infrastructure, asset management, green ICT and mining, which are areas of the ICT RDI Roadmap.

Another benefit of the collaboration will be an enhanced ability to develop human capacity and build critical mass in the ASN field. "Because of our collaboration, we are serious about developing human resources and that is exactly what we need in South Africa." - **Prof Gerhard Hancke.**

Outputs
Students trained - PhD (1); Hons (1); BSc (1)
Research chairs - 2

To create **critical mass and specialisation**, the **ASN partners** helped with the development of **NRF SARChI proposals** for research chairs to be **co-hosted with the CSIR.**

Energy
Integrated and optimised coal gasification

Dr Brian North, CSIR I Prof Thokozani Majozi, UP

Background

Coal is a key feature in South Africa's energy mix. About 285 million tonnes of the estimated 35 billion tonnes of South Africa's coal reserves is mined annually. Of this, 171 million tonnes is used domestically and 69 million tonnes is exported. The remainder is "discard" and is stockpiled.

The use of carbonaceous fossil fuels, such as coal, results in the emissions of carbon dioxide, a gas contributing to global warming. The challenge is to develop technologies that utilise coal more efficiently, and therefore emit less carbon dioxide. One promising technology is Integrated Gasification Combined Cycle (IGCC).

Response

The CSIR and UP have collaborated to optimise the two major components of IGCC technology - coal gasification and electricity production from the syngas produced. The CSIR has concentrated on coal gasification, and has specifically investigated the gasification performance of a suite of South African coals in a fluidised bed gasifier (FBG). These coals were selected because they are current and likely future power station feed.

Extensive pilot plant trials were conducted to assess their performance in terms of carbon efficiency and syngas quality under varying temperatures, residence times and degrees of oxygen enrichment.

UP has undertaken comprehensive modelling and process integration and optimisation of the gas and steam turbine systems that generate the electricity from the syngas produced in the gasification process.
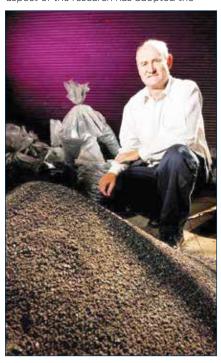
Progress

Four South African power station feed coals were gasified in the CSIR's pilot scale FBG. These coals exhibited a range of performance, with, in general, higher rank coals resulting in lower carbon conversions and a syngas of a lower calorific value.

The highest rank coal displayed such a low carbon conversion that it is considered that a secondary or integrated char re-burning stage would be required in order to make the process viable. Oxygen enrichment of the fluidising gas stream resulted in an improvement of both the carbon efficiency and the gas calorific value, with the highest values resulting from a pure oxygen/steam feed. It is notable, though, that with pure oxygen produced by cryogenic air

separation being an expensive commodity, there appears to be a "cost optimum" of partial oxygen enrichment, which can be achieved by using membrane air separation technology.

The process integration and optimisation aspect of the research has adopted the

Elcogas IGCC facility as the basis of the analysis. This facility currently has the thermal efficiency of 47%, which is the highest of all commercially operating IGCC plants globally. The application of process integration on the steam side was extended to include a contact economiser. The motivation for this extension was to exploit the remaining calorific content of the gas turbine exhaust stream to increase the temperature of boiler feed water, which is the main feed to the steam turbine. The thermal efficiency for the final optimised design is 55%. The current work focuses on the gas side of the IGCC.

Future work

The CSIR has completed the planned research on gasification. Future work will concentrate on other low or zero carbon emitting technologies such as oxy-fuel combustion and Chemical Looping. UP will build on the modelling and optimisation of the "steam side" by also optimising the gas turbine and related ancillaries. The goal is to produce a model of the complete process, from coal to electricity (via both the steam and gas turbines) to enable integration of an entire IGCC plant.

Outputs
Peer-reviewed journal articles - 7
Peer-reviewed conference papers - 10
Students trained – MEng (3); PhD (4)

*The **CSIR and UP** have **collaborated** to optimise the two **major components** of **IGCC technology - coal gasification** and **electricity production.***

Safety and security
Electronic Defence Research Centre

Duncan Stanton, CSIR I Prof Warren du Plessis, UP

Background

South Africa has a vibrant electronic warfare (EW) community which has been successful internationally. This community focuses strongly on the development and application aspects of innovation and has not given sufficient attention to basic research. The future of South African EW innovation is, therefore, jeopardised by attention to predominantly two of the three parts of the innovation chain. The Amscor LEDGER programme which is managed by the CSIR is responding to this by seeking to re-establish defence-related research, (including EW), at tertiary education institutions.

EW is essentially about enabling, managing and controlling the electromagnetic spectrum. It is a unique field because it comprises several technologies and skills relating to wideband signal processing, high-speed digital design and cutting edge hardware. However, the ability of the field to grow and innovate is constrained by the small number of young people being recruited.

Response

In response to this concern, an Electronic Defence Research Centre (EDRC) was established at UP in 2011, in collaboration with the CSIR, and with funding from the CSIR and King Abdulaziz City for Science and Technology (KACST). The goals of this centre are to perform research and innovate in the field of EW and to recruit and supervise postgraduate students in this field.

Research drives innovation by critically re-evaluating the state-of-the-art, identifying gaps, and exploring those gaps to create new solutions. Teaching and learning are inherent in this process because the state-of-the-art needs to be well-understood before a gap may be identified and innovative new solutions proposed. By learning through research, students can gain far greater insight into a field than they would by undertaking only theoretical work.

Progress

The chair of the EDRC was appointed in December 2012. Since the EDRC was established, UP has been offering Honours, Masters and doctoral degrees relevant to EW. A decision has been taken not to offer a specific degree in EW.

As part of the training, a new postgraduate course on EW, focusing on electronic attack and related electronic protection was presented in 2012 and will be presented again in 2013. A second postgraduate EW course, focusing on electronic support and related electronic protection and which is likely to be presented in 2015, is being registered. This will allow more comprehensive coverage of the extremely diverse range of fields and technologies relevant to EW. Short courses in other aspects of EW are also being developed in response to requests from the EW community.

Outputs

A workshop on future EW trends and technologies was held and a paper related to EW was presented at the Saudi International Electronics Communications and Photonics Conference in 2013. Additional papers are in preparation.

Future work

Future work will involve increasing the number of EDRC activities and participating more actively in South African and international EW events.

The goals of the EDRC can only be achieved by ensuring that the research and training conducted are relevant, and

that innovative new ideas eventually become deployed capabilities. Strong collaborations with EW experts and organisations both within South Africa and abroad are key to achieving these goals, and such collaboration will be the main focus of the EDRC in the near future.

Outputs
Students trained – Masters (1); Honours (3)
Peer-reviewed conference papers - 3
Peer-reviewed journal article - 1

Research drives innovation by **critically re-evaluating** *current practice,* ***identifying gaps*** *and* **exploring** *them to create* **new solutions.**

Other initiatives

Building indicators
(2007-2009)

Objectives:
The research team's establishment was inspired by the building performance laboratory which was developed by the CSIR, and work conducted within UP to develop an index for performance criteria beyond only architectural elements. SERA partners provided funding for the acquisition of Ecotect software – a building design and environmental simulation and analysis tool – and environmental loggers. Research activities were based primarily on field studies of vernacular architecture and the application of the Ecotect software.

Achievements:
- A Master's degree was completed on adaptive retrofit of 20th century buildings for environmental comfort in which the Boukunde Building of UP was investigated for retrofit.
- The Project focused on analysis and logging of the thermal performance of various single-material buildings, such as sod-roof buildings in Namaqualand, and Zulu bee-hive huts at the Voortrekker Monument in Pretoria.
- The results of this project have shown that, even on very hot days, the internal temperature of stone corbel structures in the Karoo stays constant at 17°C with closed doors and windows.

Sustainable rural development
(2005-present)

Objectives:
This initiative seeks to make a significant impact in rural areas through development programmes that build on the CSIR's and UP's respective strengths. The focus area team is able to assist government in addressing rural development challenges and intends becoming a 'one-stop' resource centre for government-related rural development initiatives. Abilities include assisting in the implementation of rural development projects, and ensuring the alignment of the initiatives with the developmental policies across the tiers of government.

Achievements:
- Implementation of the Greater Giyani Natural Resource Development Programme from 2005 to 2009.
- Attracting sponsorships and grants for the establishment, promotion, and commercialisation of various projects in the Greater Giyani Local Municipality.
- Initiation of a project to upgrade health care facilities in the Giyani area. This initiative was developed in collaboration with Novartis, and the Limpopo Department of Health and Social Development.
- Initiatives to expand rural development in the Eastern Cape have been started. These are expected to cover education, sanitation and nutrition.

Remote sensing
(2008-2012)

FUNDING: NRF

Objectives:
The objectives of this project include the introduction of LiDAR-based atmosphere remote sensing to South Africa; the development and improvement of atmospheric and land surface remote-sensing devices and measurement techniques; and the training of future researchers.

Achievements:
- The first scientific results of the CSIR National Laser Centre Mobile LiDAR were presented at the 2009 International Electrical and Electronics Engineers (IEEE) Geoscience and Remote Sensing Symposium.
- Networking and collaboration with many South African and international HEIs, such as Wits, TUT, UCT, UKZN, University of Addis Ababa and University of Reunion, leading to publications of several journal articles.
- Training for undergraduate students at UP on various elements of remote sensing and atmosphere thermodynamics.

Plant propagation and cultivation technologies
(2006-2010)

FUNDING: THRIP

Objectives:
The PPCT activities addressed the needs of the forestry, agriculture, and medicinal plant industries, and contributed to plant species conservation initiatives through applied innovative research and human capital development.

Achievements:
- Project to understand the inter-specific and intra-specific fertility control mechanisms of commercially important Eucalyptus species for the purpose of mass hybrid seed production implemented.
- Establishment of national and international links, including research collaboration with Global Forest Products (SA), for the development of new hybrid Pine trees for saw timber and pulp and paper production.
- Participation in a number of projects addressing emerging market sectors, such as horticulture and indigenous forestry, as well as essential oils.

Flammability testing
(2009-present)

FUNDING: CSIR; UP

Objectives:
The objectives of the team are to design and set up a laser-based system to reproduce real fire circumstances (Laser pyrolysis system); to test the flammability of micro materials using the laser pyrolysis system and, to design a flame test device based on the above studies for forensic studies purposes.

Achievements:
One MSc student is being trained at UP and a journal paper on laser pyrolysis flame characteristics has been produced jointly by UP and the CSIR. The impact of the project contained in the intellectual property under patent consideration will enable thermogravimetry analysis (TGA) manufactures to include laser heating in their TGA designs, as well as inform garment manufacturers on materials best suited for fire protection.
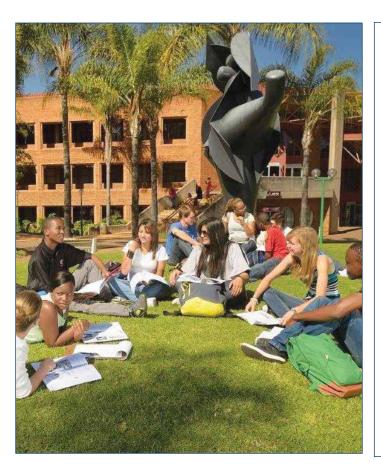
Undergraduate training

UP and the CSIR are developing a new generation of researchers. In 2011 and 2012, 57 CSIR bursaries (8 Honours, 49 Bachelor's) were awarded to undergraduate students studying in the areas of science and engineering – such as mechanical engineering, computer science and microbiology – at UP. They have had rewarding experiences at UP and look forward to fulfilling careers.

Jaco van den Bergh is studying for a BEng (Honours) degree in computer engineering, after completing his BEng in the same field in 2012. "I was fortunate to be awarded a CSIR bursary to study for both qualifications.

"The BEng degree covered work in computer programming and hardware, mathematics, statistics as well as fundamental electrical and electronic concepts. It involved a fair amount of both theoretical and practical work. Honours studies are completed in research groups. I have participated in the Advanced Sensor Networks group.

"After completing my studies, I will work at the CSIR, where I have previously done vacation work. The vacation work that I did has introduced me to the type of work that I will do in full time employment. Research, problem solving and mathematically-intensive programming are the most interesting to me. The work involves simulations for the South African Defence Force, helping it to be more prepared for attack or defensive situations.

"Through the help that I have received from the CSIR, both financially and through work experience, I managed to complete my BEng degree in the minimum amount of time, *cum laude*. I am thankful for that, and for the support that I have received from the university, and look forward to using my acquired skills to the country's benefit next year."

Amy Beukes started her academic path in 2010 through the Bachelor of Town and Regional Planning programme. "I am currently in my final year and primarily involved in a research project which deals with labour migration (to urban areas) in South Africa.

"The programme has equipped me with the skills to plan at the neighbourhood, metropolitan, regional and supra-national level. It has also provided me with multidisciplinary knowledge on aspects of planning such as law and policy, sociology, urban design, rural development, spatial planning, transport planning and services provision - which are all important for planning in South Africa.

"The skills that I have developed and the knowledge that I have obtained will enable me to address poverty and inequality, promote sustainable development and equitable allocation of resources, and improve economic efficiency in the country. I could work in Government and directly influence policy; in the private sector where I would promote economic development and improve living conditions through integrated planning and urban design; or in academia and research, where I can be part of a community that produces knowledge and information on the different aspects of planning. But my ambition is to work in a research environment before continuing my university education.

"Being a student at UP, with the support of the CSIR, has been an incredible privilege. I have interacted with some of the most knowledgeable people in their academic fields. I have received academic and personal mentorship, and acknowledgement for my achievements. A strong sense of patriotism as well as contribution to the community is promoted by the university."

Mayur Tikam is doing his final year of a BEng (Mechanical Engineering) degree through a CSIR bursary. The degree covers a broad spectrum of specialised fields in the applied sciences, related to mechanical systems, such as machine design, heat and mass transfer, fluid mechanics, vibrations and noise, thermodynamics, structural mechanics etc. His final year elective module will be in the field of vehicle engineering.

"Mechanical Engineering forms the basis of the design of all machinery, equipment, devices, tools and apparatus used in various applications. The profession, therefore, plays a key role in the development of technology to improve the quality of life. Being supported by the CSIR is great, as it will expose me to the engineering industry and provide me with a platform through which I can make a contribution to the engineering industry in South Africa.

"After completing my undergraduate degree, I want to study for BEng (Hons) and MEng qualifications, continuing to be a part of the CSIR, and playing a role in research and development of technology.

"The transition from high school to university has been fairly easy, but I had to adapt my study methods to suit the increased work load and complexity of the information provided. I have also had to define a balance between work and leisure to make my life as a student enjoyable and productive."

*Responding to **development challenges** requires **qualified professionals** who can deal with the requirements and expectations of **government, industry and the public.***

Supervised postgraduate research

In 2011 and 2012, 157 staff members (35 Honours, 82 Masters, and 40 Doctoral) were supported by the CSIR to study for higher qualifications. Some were supervised by UP and CSIR researchers and involved in projects initiated by either, or both institutions as part of their graduate programmes.

*By **learning through research**, students can gain **far greater insight** into a **field** than they would by undertaking only **theoretical work.***

Characterisation of the fire properties of polyethylene/graphite composites using laser irradiation and infrared thermography

Washington Mhike I **Supervisor:** *Prof Walter Focke, UP*

Background

The extensive use of polymers has exacerbated the risk of fire hazards in different environments due to their high flammability. Flame retardant additives are often used in polymers in an attempt to extenuate these fire hazards.

The polyolefin sub-group of polymers present challenges in applications which require flame retardancy due to their aliphatic nature. They have high heats of combustion and release significant amounts of fuel during their combustion. They are also non-charring during combustion. One of the parameters used to characterise flame retardant materials is the time to ignition. The time to ignition gives a measure of the ignibility of the material. A longer time to ignition delays the combustion process, which is desirable in a fire situation.

The thermal conductivity of a material determines how effectively heat will be dissipated when it is exposed to a heat source. In a low conductivity material, heat will remain concentrated on one area and the material will ignite earlier. However, in a material with high conductivity, the heat is dissipated effectively, and the material will take a longer time to ignite. Natural flake graphite is a layered mineral comprising stacked graphene sheets of covalently bonded carbon atoms. The thermal conductivity of the flakes is anisotropic. At room temperature it has an in-plane conductivity of 3000 W/mK.

Expandable graphite is made by partial oxidation of the graphene sheets with simultaneous intercalation (i.e., insertion) of charge-neutralising guest species (e.g., sulphuric acid anions) in-between the stacked graphene layers. Upon exposure to high temperatures, the intercalated guest ions decompose forming a gas that causes the flakes to expand rapidly in a worm-like manner and to occupy a much larger volume. Expandable graphite is an effective intumescent flame retardant for polyethylene at a loading of 10 wt% and above. This means that it could impart flame retardant properties to polyolefins due to its intumescency and higher thermal conductivity.

Response

Polyethylene/graphite composites were fabricated with different graphite forms by rotational moulding. The aim was to characterise polyethylene/graphite composites fabricated with different graphite forms by their thermal response, using laser irradiation as a well-defined heat source and infrared thermography. An infrared camera converts infrared radiation emitted from the composites into an electrical signal that is then used to determine the temperature of the composite. It is predicted that the different polyethylene/graphite composites will exhibit different time-temperature profiles in accordance with their thermal properties. This should in turn give an insight into how the thermal properties affect their fire behaviour, enabling the determination and prediction of such important parameters as thermal diffusivities of the composites. Correlations with the established cone calorimeter fire testing method are expected together with the micro-flammability tester which is being developed.

Progress

Initial results from the laser irradiation/infrared thermography of the composites showed that inclusion of graphite in the polyethylene matrix does improve the heat dissipation of the polymer composites. This is in agreement with results obtained from the cone calorimeter tests which showed a significant improvement in the time to ignition of the composites.

Signalling response of generated nano-calcium phosphate scaffolds to improve cell activity in bone restructuring

Ilse Wepener | **Supervisors:** *Dr Wim Richter, CSIR; Prof Anna Joubert, UP*

Background

Strong, bioinert materials were, for a long time, the focus for bone replacement and repair. Research interest has since moved to bioactive as well as bioresorbable materials that can mimic living tissue and aid the healing process (i.e. be replaced by natural bone). Bioactive materials interact with the surrounding tissue through ion-exchange. This leads to the formation of a biologically active carbonate apatite layer that is chemically equivalent to the mineral phase of bone, on the implant. Bioresorbable materials start to dissolve when implanted in the body, whilst being replaced by tissue.

The most widely used bioactive bone substitutes are calcium phosphate-based materials. However, these materials [i.e. hydroxyapatite (HA) and ß-tricalcium phosphate (TCP)] are not ideal for bone repair and replacement. Calcium phosphates, although chemically similar to bone, are brittle and lack collagen fibres which are important for strength. The general bioactivity of current substitutes is slow and limits the rate of bone reconstruction. The ideal biomaterial for bone replacement should be completely resorbed by osteoclasts over time, while osteoblastic activity deposits new mineralised bone at the site.

These dynamic functions cannot be performed by "dead material" such as HA or TCP. Therefore it is important that novel bioceramics are developed that will initially function as bone replacement - attending to all the requirements such as biocompatibility, structure, filler, as well as load-bearing. These bioceramics should also be able to activate the cellular response to recruit osteoclasts and osteoblasts to the implant site for the resorbtion of the implant whilst enhancing the formation of new bone.

Response

The purpose of this study was to generate electrospun biphasic nanobioceramic scaffolds for bone tissue engineering and to elucidate the *in vitro* signalling response making use of osteoclast-like cells and a human osteoblast cell line.

The synthesis of the electrospun scaffolds was done at the CSIR Nonwovens & Composites group in Port Elizabeth and the CSIR Smart Polymers group in Pretoria. Characterisation of the scaffolds and growth of the cells were performed at the CSIR in Pretoria, while most of the *in vitro* analysis assays were done at UP.

Progress

Scaffolds were characterised by scanning electron microscopy (SEM) and Attentuated Total Reflectance Fourier Transform Infrared (ATR-FTIR). Osteoblasts, as well as monocytes that were differentiated into osteoclast-like cells, were cultured separately on the biphasic bioceramic scaffolds and the proliferation, adhesion and cellular response were determined using lactate dehydrogenase (LDH) cytotoxicity assay, nucleus and cytoskeleton dynamics, analysis of the cell cycle progression, measurement of the mitochondrial membrane potential and the detection of phosphatidylserine expression. For the osteoblast cells, further studies included Alizarin Red-S staining to visualise mineralisation of the cells, intra-cellular calcium concentration and nitric oxide

detection, as well as confocal studies on the enzymes inducible nitric oxide synthase (iNOS) and endothelial nitric oxide synthase (eNOS) expression. SEM analysis of the biphasic bioceramic scaffolds revealed nano fibers spun in a mesh-like scaffold. Results indicate that the biphasic bioceramic electrospun scaffolds are biocompatible and have no significant negative effects on either osteoblasts or osteoclast-like cells *in vitro*. These electrospun scaffolds can potentially be used in the replacement and repair of damaged bone.

Outputs
Peer-reviewed journal article - 1
Chapter in book - 1

*These **electrospun scaffolds** can **potentially** be used in the **replacement** and **repair** of **damaged bone**.*

Water quality modelling and application of mixed-integer programming on water quality management

Christopher Mahlathi | **Supervisors:** *Dr Njabulo Siyakatshana, CSIR; Prof Evans Chirwa, UP*

Background

Water quality modelling is used as a supporting decision-making tool in water resource management and planning. Optimisation through water quality modelling assists in reducing the number of possible options that could improve management. Decision variables could be selecting appropriate levels of waste water treatment before discharge into a river, or choosing appropriate locations where discharges may be permitted without violating set water quality standards. The study focused on one of the catchments of the Upper Olifants River, which has been subjected to extensive loading of contaminants from mining operations and wastewater treatment plants. Most of the wastewater treatment plants are not operating optimally, and most parts of the catchments violate set green drop standards in terms of Dissolved Oxygen (DO) and related Biochemical Oxygen Demand (BOD).

Response

The aim was to develop a water quality model to predict DO concentration in the river, and to use it to design a wastewater treatment network that would help meet water quality standards. Apart from DO, several green drop criteria exist. However, DO and BOD have been extensively studied and can be more easily measured.

Mixed-integer programming techniques were applied on a system that has numerous treatment facilities discharging waste water into the river. Each facility was assumed to be capable of achieving certain treatment levels before the discharge. The objective of the model was to assign minimum possible treatment levels that do not violate water quality standards after discharge, while minimising the treatment cost. Such a model could assist water quality management specialists to develop suitable waste water management systems. It may also be used to identify specific areas in the river where standards are violated, and more cost effective interventions can be made to resolve the problem. The objective is to treat water as efficiently as possible, at a minimum cost, using existing facilities.

Progress

A stream simulation water quality model was developed for a semi-hypothetical upper Olifants catchment to predict dissolved oxygen concentration. The model succeeded in providing a good fit to the data at those streams (upper Olifants catchment and other streams connected to this catchment). Using non-linear regression techniques, a mixed-integer optimisation problem involving nine treatment facilities, capable of achieving three different treatment levels, was solved, and produced a feasible solution which ensured that dissolved oxygen concentration was kept above 7 mg/L at the catchment.

Current work involves finding ways of acquiring more water quality data at the catchment; the solutions obtained will consequently not be for a semi-hypothetical situation but for a real one. This will enable treatment plants to be designed to operate more cost-effectively, as well as efficiently, by ensuring compliance with given stream drop standards.

Using **non-linear regression techniques,** *a* **mixed-integer optimisation** *problem involving* **nine treatment facilities**, *capable of achieving* **three different treatment levels,** *was solved.*

Joint teaching

Strategic environmental management

Dr Marius Claassen, CSIR I Prof Willem Ferguson, UP

Background

The UP Centre for Environmental Studies offers a multidisciplinary graduate training programme in the field of environmental science, in collaboration with the CSIR. New national environment legislation, as well as the global consumer-driven environmental awareness of the industry, has generated a need to respond comprehensively to environment and development concerns. This requires qualified graduate professionals who can incorporate these new requirements and expectations of government, industry and the public.

A balance between professional specialisation and a broad understanding of the varied and interacting dimensions of environmental problems is required to improve management of natural resources and promote sustainable economic and social development.

Purpose

The complementary capabilities and aspirations of the CSIR and UP relating to adapting to and mitigating global change; ecosystem services delivery; water quality and quantity; and environmental solutions for a green economy provide opportunity for a mutually-beneficial partnership in postgraduate education and joint research. The focus of the collaboration has been the teaching of aspects of the Strategic Environmental Management (SEM) module at UP by the CSIR. Students who select this module have the opportunity to do research using information from CSIR projects. UP provides strategic direction and specialist inputs to teaching and research projects.

Progress

SEM is offered as an elective module for various postgraduate programmes, and attracts students, from various departments, of the humanities and natural sciences.

The module explains how understanding of sustainable development has been influenced by societal perspectives and values, as well as economic and environmental realities.

Since many of the principles and best practices that are used in business are also applicable to partners, such as government and communities, students learn generic business management process and their application in SEM. They also learn how to prepare and interpret plans; and, understand public policy-making.

Students are also introduced to water management and governance issues; the strategy development process which is based on a vision of a desired environmental state; decision-making and processes that are used; review and interpretation of specialist environmental reports; the role of spatial information in planning; the tools that are used in environmental management; the role of infrastructure in socio-economic development; monitoring and evaluation of development activities to improve service delivery and allocation of resources; causes and potential impacts of climate change; and, communicating through state-of-the-environment reports.

The course has been very popular, with 15-20 students registering every year. CSIR staff members have also become increasingly involved in supervising the dissertations of students who have completed the module. The past success and growing demand has created the opportunity to be more selective in accepting students, and producing quality research outputs.

The module is updated annually. The following components are part of the current curriculum:

Study unit 1: Sustainable Development - Dr Marius Claassen

Study unit 2: The Planning and Management Process - Dr Marius Claassen

Study unit 3: Adaptive management - Dr Marius Claassen

Study unit 4: Regional Water Management - Dr Inga Jacobs

Study unit 5: Policy - Nikki Funke

Study unit 6: Strategy - Dr Marius Claassen

Study unit 7: Plans - Dr Marius Claassen
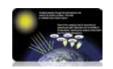
Study unit 8: Scenarios - Dr Marius Claassen

Study unit 9: Visioning - Dr Marius Claassen

Study unit 10: Infrastructure - Dr Kevin Wall

Study unit 11a: Climate Change - Dr Marius Claassen
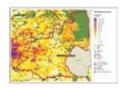
Study unit 11b: State of the Environment - Dr Marius Claassen

Study unit 12: Decision-making and Risk - Dr Marius Claassen

Study unit 13: Interpretation and review - Dr Marius Claassen

Study unit 14: Spatial Planning and Development - Johan Maritz

Study unit 15: Introduction to IEM Tools - Terry Calmeyer

Study unit 16: Society, Culture and Values - Karen Nortje

INFRASTRUCTURE AND EQUIPMENT
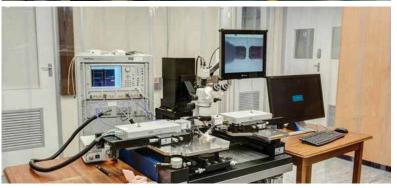
Infrastructure and equipment enable research to be performed effectively according to established standards. Research by UP and the CSIR has been enhanced by sharing some of the facilities and equipment that are located in the two institutions.

Wind tunnel which simulates flight conditions in a controlled environment to provide a test, measurement and evaluation service to the SA aeronautical industry

Fibres, Textiles and Biocomposites facility (Spun lacing Nonwoven Line) enables R&D in natural fibres and textiles with a focus on natural fibre based composites and biocomposites

Millimeter-wave vector network analyser (70 kHZ-110 GHz) measures the magnitude and phase of an electrical network, like a filter or amplifier.

Equipment/facility	Purpose	Location
Fibres, textiles and biocomposites equipment	Supports R&D in natural fibres and textiles with a focus on natural fibre based composites and biocomposites	CSIR Materials Science and Manufacturing
Subsonic wind tunnels which include: • Low Speed Wind Tunnel • 7 metre Wind Tunnel	Simulate flight conditions in a controlled environment to provide a test, measurement and evaluation (TME) service to the SA aeronautical industry in subsonic, transonic, and supersonic flows, and, where possible, tertiary institution access to world class facilities.	CSIR, Defence, Peace, Safety and Security
Transonic wind tunnel (Medium Speed Wind Tunnel)		
Tri-sonic wind tunnel (High Speed Wind Tunnel)		
Detonics, Ballistics and Explosives Laboratory	To conduct research in the short event domain, specifically with energetic materials. The capability is required to characterise explosive events and to develop protection systems against threats.	
High Performance Computing	To accelerate the research on modelling and simulation through provision of high-end computing resources	CSIR Meraka
National Synthetic Compound Library	To collate, manage, develop, and promote access to, and the use of the more than 20 000 synthetic chemical compounds. These compounds, which comprise relatively novel pharmacophore classes, are used by researchers as the building blocks for drug discovery and development programmes.	CSIR Biosciences
Natural Product Library	A national repository of medical plants, medicinal plant extracts, and indigenous fungi and algae.	
Equipment for production of herbal and algal products	Used mainly for the development of technologies towards a commercial outcome. The infrastructure is also used to produce market samples for traditional healers and SMMEs.	
Skukuza flux tower	Monitors the exchange of energy, water and CO_2 between the land surface and atmosphere to calibrate and validate satellite data and models.	CSIR Natural Resources and Environment
Precision CO_2 measurement instruments.	Monitors atmospheric greenhouse gases (CO_2 and CH_4) with sufficient precision and accuracy that the origin of the gases can be determined	
Lasers and diagnostics equipment that cover a range in laser parameters: wavelength, power, energy, bandwidth and repetition rate, etc.	Human Capital development through performance of basic and applied research in priority multidisciplinary areas where lasers are used, such as chemistry, physics, engineering, biology and the health sciences.	CSIR National Laser Centre
Optomec LENS 850R Laser-based Additive Manufacturing system	R&D in advanced manufacturing technologies, specifically laser-based additive manufacturing	
Coastal Modelling Hall for analysis and design of port infrastructure	To conduct contract R&D for customers wishing to build or upgrade ports and other coastal infrastructure through physical and numerical modelling.	CSIR Built Environment

300 mm / 12 inch Wafer Probing Station	A wafer probing station is the simplest and most direct method of testing un-encapsulated die (a portion/chip of a wafer).	UP Faculty of Engineering, Built Environment and Information Technology
Millimeter-wave vector network analyser (70 kHZ-110 GHz)	A vector network analyser (VNA) measures the magnitude and phase of an electrical network, like a filter or amplifier.	
Geotechnical Centrifuge	A geotechnical centrifuge enables model studies to be carried out on a wide range of civil engineering (and other) problems in which the self-weight of material is important.	
Los Gatos Research Liquid-Water Isotope Analyzer	A portable bench-top sized device that uses laser absorption spectroscopy to measure ratios of stable hydrogen and oxygen isotopes in liquid water samples. The optional auto-injector allows for the rapid, automated measurement of multiple samples.	UP Faculty of Natural and Agricultural Sciences
Scanning Probe Microscope (SPM) for scanning capacitance microscopy (SCM) and nano-scale deep level transient spectroscopy (nano-DLTS)	Performs all the major SPM techniques to measure surface characteristics for semiconductor wafers, lithography masks, magnetic media, CDs/DVDs, biomaterials, optics, and other samples up to 200mm in diameter.	
3500xl Genetic Analyser	Used for long-read NA sequencing ≥1000 bp and also for versatile, demanding fragment analysis such as microsatellite, SNP, AFLP, LOH, MPLA and t-RFLP applications.	

INDICATORS OF COLLABORATION

Collaborative research projects implemented

Project name										
Natural resources and agriculture	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Suiker Toekening		•								
Agro-forestry systems for improved food production through the efficient use of water		•	•	•						
Agro-forestry systems for improved food production				•	•	•	•			
Evaluating ground geophysical techniques on Waterberg coal fields				•	•					
Mathematical modelling of solar glint on water				•	•					
Guidelines for irrigation management in pasture production				•	•	•	•	•	•	
Abrasive and/or magnetic nanoparticles for use in biofilm control, with the potential use of SphereZym technology for this purpose					•	•	•	•	•	
Centre for Mycological Studies					•	•	•	•	•	•
Microscopic analysis and identification of species					•	•				
Tuneable photosensitive UV sensors					•	•	•	•		
Immunogenicity of glutamine synthase					•	•	•	•	•	•
Understanding the role of antinutritional factors in soybean: Down-regulation of trypsin inhibitors and its impact on plant and grain quality					•					
Genetic enhancement of nutritional quality of grain sorghum *S. bicolour* (L. Moench) by elevating the lysinecontent and improving the sorghum protein digestibility					•					
Water use of fruit tree orchards					•	•	•	•	•	•
Development of natural HIV/AIDS compound					•	•	•	•		
Helichrysum species								•	•	•
Microbial water quality								•		

Project name	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Construction and evaluation of and enzymatic nitric oxide reduction system								•		
Investigation of the contamination of water resources by agricultural chemicals and the impact on environmental health								•	•	•
The effect of added stearic acid on formation and characteristics of amylose-lipid nano-complexes during RVA pasting and extrusion of teff and maize starch								•	•	•
Research in climate and health for the Applied Centre for Climate and Earth System Science (ACCESS)								•	•	•
Cosmeceuticals										•
Multiple scatterer tracking in high range resolution radar images									•	
Automation and improvement of microwave egg pasteuriser									•	
Buchu oil as an anti-aging product and BP5 to assist in the prevention of hair loss								•	•	•
DPM baseline for the platinum mines									•	•
POL-SABINA - Policy and support for Southern African Natural Product partnership							•	•	•	•
A functional genomics approach to validate polyamine metabolism as a drug target in the malaria parasite *Plasmodium falciparum*					•	•	•			
Risk assessment of pollution in surface waters of the upper Olifants River system: implications for aquatic ecosystem health								•	•	•

Project name										
Engineering and built environment	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Investigation and development of a biodegradable product	•	•	•							
Lasers in Chemistry Seminar 2010							•	•		
Rhinowall: Structural testing			•							
Development of reconfigurable machine/system for South African SMMEs					•	•	•	•	•	
Un-Cooled IR sensors					•	•	•	•	•	
Electronic warfare research						•	•			

Directed acoustic-energy weapons							•	•			
Establishment of a chair in electronic defence research											•
Hybrid X-band phased array transceiver subsystems											•
Next generation microsphere products										•	•
Lidar and atmosphere remote sensing and atmosphere research over South Africa and Indian Ocean								•	•	•	•
Laser cladding of low carbon modified martensitic stainless steels										•	•
Mobility research										•	•
Mine protection – Non-linear and high strain rate material research										•	•
ROPS development										•	•
Light vehicle mobility demonstrator										•	•
BALLAST										•	•
Construction of trial sections on road R104											•
Pilot study investigating the interaction and effects for state highway pavements, trucks, freight and logistics											•
Assessment of impact of road roughness on vehicle dynamics											•
Development of a mechanistic seal model to be integrated in the South African Pavement Design Method											•
The potential effects of deteriorating road conditions in South Africa											•
UVGI photoradiogoniometry											•
Tshwane IPCP clinic assessments											•
Hydropower											•
Using satellite imagery to determine mine fields using hyperspectral data											•
Effectively managing GIS projects in the Gauteng provincial government											•
Gauteng Integrated Modelling Centre											•
Modelling a national health spatial data infrastructure for Namibia											•

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Ad hoc collaboration (follow-up to the project "Volunteered geographical information for spatial data infrastructures and geoportals")										•
Ad hoc collaboration within Geographic information/ Geomatics.										•
Ad hoc collaboration within the Commission on Geoinformation Infrastructure and Standards of the International Cartographic Association										•

Project name										
Health	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Development of a cell culture-based bioactivity screening method for maximal cell attachment and growth on biomaterials		•								
Hydroxyapatite coated alloplastic implant auricular reconstruction: Animal model				•						
Cell delivery for soft tissue augmentation								•	•	•
TB and HIV infection prevention and control								•	•	•
Oxygen carrier for organ preservation	•	•	•	•	•	•	•	•	•	•
Dermapearl									•	•
Novel virus protein particles as delivery systems for recombinant animal vaccines	•	•	•	•	•	•				
Programme in biotechnology			•	•	•	•	•	•		
Biological studies on the natural product pavettamine and its analogues			•	•	•	•	•	•		
New compounds with anti-viral activity			•	•	•					
Research on helichrysum in the field of herpes and antivirals				•	•	•	•			
3D Body scanning of various population groups in South Africa and Southern Africa						•	•	•	•	•
TB nano drug delivery			•	•	•	•	•	•	•	•
IF Nguni								•		
Evaluating the inclusion of CSIR technology in UP technology for mosquito repellents					•	•				
Malaria Gates								•		

Project name										
ICT	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Analysis of sea images via the discrete pulse transformation					•	•				
Discrete pulse transformation of images: properties and applications							•	•	•	•
Design of a CMOS-based phase noise measurement IC, design & implementation of a RFID-based registration system, design of a CMOS based complex delay-lock loop synchronisation scheme				•						
Estimation algorithms and computer simulation					•	•				
Standardised methods for the evaluation of effectivity of Jamming Spech communication				•		•	•	•		
RoboCup participation 2008 - Stimulating robotics research in South African universities							•	•		
Design and implementation of a UHF RFID reader integrated circuit							•	•		
Classification and identification of radar and EW transmitters							•	•		
Developing language learning technologies for Southern Africa				•	•	•				
RF sub-systems for the MM-Wave range								•	•	•
Phase 1 of Project focusing on a soft core processor architecture optimised for radar signal processing applications								•		
Gated IC sensor								•	•	•
Graphic model approaches to situation awareness.									•	•
Phase 2 - Multiple scattered tracking in high range resolution radar images										•
South African research chair in advanced sensor networks										•
Integrated LNA for low probability of intercept signal detection receivers										•
Design and implementation of an adaptive noise cancelling front end for cochlear implants			•							
Discrete pulse transformation of images									•	•
Image processing: Lulu workshop									•	•
Autonomous systems									•	•
Text resources for speech processing in the SA languages					•	•	•			

Patents

Title / Inventors	Abstract
Longlegg UP: Elna Buys CSIR: Corinda Erasmus, Mathys Johannes Rossouw	In-shell pasteurisation of eggs using microwaves
Bio-reactor system UP: Van Der Merwe Schalk, Adriaan Jacobus Van Wyk CSIR: Robert Paul Bond, Francis Sean Moolman	Bio-reactor device and a method of cultivating live cells. The device comprises a holder (which contains a matrix of porous foam material in whose interior live cells are anchored), and a liquid. The method involves perfusing the oxygen carrier liquid through the matrix to deliver oxygen to the cells and to absorb carbon dioxide from the cells.
Food coating (edible film) UP: John Reginald Nuttall Taylor CSIR: Sonya Buchner	A composition from which a coating or film can be formed, comprising at least one prolamin protein, gluconic acid and/or a gluconic acid derivative as a plasticiser, and a solvent for the protein and the plasticiser.
Pavettamine UP: R. Anitra Schultz, Dharmarai Naicker, Nel Fourie CSIR: Moira Bode, Robert Vleggaar, Paul J. Gates,	New compounds for the treatment of cancer
Use of an extract of *Helichrysum* for the treatment of AIDS UP: Nial Mark Harding, Rooyen Schalk-Willem Van, Der Merwe Marina Van, Jacobus Johannes Marion Meyer CSIR: Nivan Moodley, Paolo Meoni, Vinesh Jaichand Maharaj	The use of an extract of *Helichrysum*, for the treatment of HIV/AIDS
Cell proliferation (autoculture) UP: Wyk Adriaan Jacobus Van CSIR: Francis Sean Moolman, Kersch Naidoo	The invention is for a cell proliferation apparatus for the automated culturing of cells. It includes a bio-reactor containing a stimulus-responsive 3D cell scaffold which can reverse its surface properties between hydrophilic and hydrophobic states.
Bulking of soft tissue UP: Paul Wilhelm Richter, Van Der Merwe Schalk CSIR: Kersch Naidoo	A soft tissue bulking material consisting of particles with a rounded polymeric shell, an internal cavity, and a port/opening in the shell.
Preparation of starch nanoparticles UP: Naushad Emmambux, Wokadala Obiro Cuthbert CSIR: Ray Suprakas	The invention relates to preparation of starch nanoparticles using starch pasting in the presence of added stearic acid followed by thermal stable enzymatic hydrolysis.

Joint outputs resulting from supervised and joint research

(2011 and 2012 publications only)

Authors	Title of publication	Publication
Peer-reviewed journal articles		**2012**
Willemse EJ; Joubert JW	Applying min-max k postmen problems to the routing of security guards	Journal of the Operational Research Society, Vol. 63, Pages: 245-260 Feb 2012
Landman S; Engelbrecht FA; Engelbrecht CJ; Dyson LL; Landman WA	A short-range weather prediction system for South Africa based on a multi-model approach	Water SA, Vol. 38 (5), Pages: 765-773 Oct 2012
Focke WW; Van der Westhuizen I; Lofté Grobler AB; Nshoane KT; Reddy JK; Luyt AS	The effect of synthetic antioxidants on the oxidative stability of biodiesel	Fuel, Vol. 94, Pages: 227-233 Apr 2012
Cooper AK; Moellering H; Hjelmager J; Rapant P; Delgado T; Laurent D; Coetzee S; Danko DM; Duren U; Iwaniak A; Brodeur J; Abad P; Huet M; Rajabifard A	A spatial data infrastructure model from the computational viewpoint	International Journal of Geographical Information Science, Pages: DOI: 10.1080/13658816.2012.741239 Oct 2012
Oberholster PJ; Myburgh JG; Ashton PJ; Coetzee JJ; Botha A-M	Bioaccumulation of aluminium and iron in the food chain of Lake Loskop, South Africa	Ecotoxicology and Environmental Safety, Vol. 75 (1), Pages: 134-141 Jan 2012
Seid R; Majozi T	A robust mathematical formulation for multipurpose batch plants	Chemical Engineering Science, Vol. 68 (1), Pages: 36-53 Jan 2012
Seid R; Majozi T	A novel technique for prediction of time points for scheduling of multipurpose batch plants	Chemical Engineering Science, Vol. 68 (1), Pages: 54-71 Jan 2012
Sha G; Moller H; Stumpf WE; Xia JH; Govender G; Ringer SP	Solute nanostructures and their strengthening effects in Al-7Si-0.6Mg alloy F357	Acta Materialia, Vol. 60 (2), Pages: 692-701 Jan 2012
Nonyane DR; Thokozani M	Long term scheduling technique for wastewater minimisation in multipurpose batch processes	Applied Mathematical Modelling, Vol. 36 (5), Pages: 2142-2168 May 2012
Heyns T; Godsill SJ; De Villiers JP; Heyns S	Statistical gear health analysis which is robust to fluctuating loads and operating speeds	Mechanical Systems and Signal Processing, Vol. 27, Pages: 651-666 Feb 2012

Authors	Title of publication	Publication
Peer-reviewed journal articles		**2012**
Heyns T; Heyns PS; De Villiers JP	A method for real-time condition monitoring of haul roads based on Bayesian parameter estimation	Journal of Terramechanics, Vol. 49 (2), Pages: 103-113 Apr 2012
Bulani SI; Moleleki L; Albertyn J; Moleleki N	Development of a novel rDNA based plasmid for enhanced cell surface display on Yarrowia lipolytica	AMB Express, Vol. 2 (27), Pages: DOI: 10.1186/2191-0855-2-27 May 2012
Landman WA; Berakic A	Multi-model forecast skill for mid-summer rainfall over southern Africa	International Journal of Climatology, Vol. 32(2), Pages: 303-314 Feb 2012
Ramulifho T; Ozoemena KI; Modibedi RM; Jafta CJ; Mathe MK	Fast microwave-assisted solvothermal synthesis of metal nanoparticles (Pd, Ni, Sn) supported on sulfonated MWCNTs: Pd-based bimetallic catalysts for ethanol oxidation in alkaline medium	Electrochimica Acta, Vol. 59, Pages: 310-320 Jan 2012
Broughton EK; Brent AC; Haywood L	Application of a multi-criteria analysis approach for decision-making in the energy sector: the case of concentrating solar power in South Africa	Energy and Environment, Vol. 23 (8), Pages: 1221-1232 Dec 2012
Oosthuizen MA; Oberholzer HM; Scriba MR; Van der Spuy WJ; Pretorius E	Evaluation of the morphological changes in the lungs of BALB/c mice after inhalation of spherical and rod-shaped titanium nanoparticles	Micron, Vol. 43 (8), Pages: 863-869 Aug 2012
Du Toit L; Bennett NC; Nickless A; Whiting MJ	Influence of spatial environment on maze learning in an African mole-rat	Animal Cognition, Pages: DOI: 10.1007/s10071-012-0503-0 May 2012
Karsten AE; Singh A; Karsten PA; Braun MWH	Diffuse reflectance spectroscopy as a tool to measure the absorption coefficient in skin: system calibration	Lasers in Medical Science, Pages: DOI: 10.1007/s10103-012-1079-2 Mar 2012
Adekanmi AE; Fouche G; Steenkamp V	Cytotoxicity and acetylcholinesterase inhibitory activity of an isolated crinine alkaloid from Boophane disticha (Amaryllidaceae)	Journal of Ethnopharmacology, Vol. 143 (2), Pages: 572-578 Sep 2012
Wessels KJ; Van den Bergh F; Scholes RJ	Limits to detectability of land degradation by trend analysis of vegetation index data	Remote Sensing of Environment, Vol. 125, Pages: 10-22 Oct 2012
Grobler TL; Ackermann ER; Van Zyl AJ; Olivier JC; Kleynhans W; Salmon BP	Using Page's cumulative sum test on MODIS time series to detect land-cover changes	IEEE Geoscience and Remote Sensing Letters, Vol. 99, Pages: 10.1109/LGRS.2012.2205556 Jul 2012
Grobler TL; Ackermann ER; Olivier JC; Van Zyl AJ; Kleynhans W	Land-cover separability analysis of MODIS time-series data using a combined simple harmonic oscillator and a mean reverting stochastic process	IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Vol. 5 (3), Pages: 857-866 Jun 2012

Jansen van Rensburg GJ; Wilke DN; Kok S	Human skull shape and masticatory induced stress: objective comparison through the use of non-rigid registration	International Journal for Numerical Methods in Biomedical Engineering, Vol. 28(1), Pages: 170-185 Jan 2012
Mashapa MG; Chetty N; Sinha Ray S	Defect complexes in carbon and boron nitride nanotubes	Journal of Nanoscience and Nanotechnology, Vol. 12 (9), Pages: 7021-7029 May 2012
Mashapa MG; Chetty N; Sinha Ray S	Ab initio studies of vacancies in (8,0) and (8,8) single-walled carbon and boron nitride nanotubes	Journal of Nanoscience and Nanotechnology, Vol. 12 (9), Pages: 7030-7036 Sep 2012
Ackermann ER; Grobler TL; Kleynhans W; Olivier JC; Salmon BP; Van Zyl AJ	Cavalieri integration	Quaestiones Mathematicae, Vol. 35 (3), Pages: 265-296 Sep 2012
Meyers BC; Snedden GC; Meyer JP; Roos TH; Mahmood GI	Three-component particle image velocimetry in a generic can-type gas turbine combustor	Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy, Vol. 226 (7), Pages: 892-906 Nov 2012
Rotherham LS; Maserumule C; Dheda K; Theron J; Khati M	Selection and application of ssDNA aptamers to detect active TB from sputum samples	PLoS ONE, Vol. 7 (10), Pages: DOI: 10.1371/journal.pone.0046862 Oct 2012
Jafta CJ; Ozoemena KI; Mathe MK; Roos WD	Synthesis, characterisation and electrochemical intercalation kinetics of nanostructured aluminium-doped Li[Li0.2Mn0.54Ni0.13Co0.13]O2 cathode material for lithium ion battery	Electrochimica Acta, Vol. 85, Pages: 411-422 Aug 2012
Robb GN; Woodborne S; Bennett NC	Subterranean sympatry: an investigation into diet using stable isotope analysis	PLoS ONE, Vol. 7 (11), 10pp Nov 2012
Heyns T; De Villiers JP; Heyns PS	Consistent haul road condition monitoring by means of vehicle response normalisation with Gaussian processes	Engineering Applications of Artificial Intelligence, Vol. 25 (8), Pages: 1752-1760 Dec 2012
Heyns T; Heyns PS; De Villiers JP	Combining synchronous averaging with a Gaussian mixture model novelty detection scheme for vibration-based condition monitoring of a gearbox	Mechanical Systems and Signal Processing, Vol. 32, Pages: 200-215 Oct 2012
Rossouw CL; Chetty A; Moolman FS; Birkholtz L-M; Hoppe H; Mancama DT	Thermo-responsive non-woven scaffolds for "smart" 3D cell culture	Biotechnology and Bioengineering, Vol. 109 (8), Pages: 2147-2158 Aug 2012
Wepener I; Richter W; Van Papendorp D; Joubert AM	*In vitro* osteoclast-like and osteoblast cells' response to electrospun calcium phosphate biphasic candidate scaffolds for bone tissue engineering	Journal of Materials Science: Materials in Medicine, Vol. 23 (12), Pages: 3029-3040 Sep 2012
Mzenda V; De Jongh D	Climate change governance in the South African mining sector	Journal of Corporate Citizenship, Vol. 44, Pages: 45-67 Jul 2012

Authors	Title of publication	Publication
Peer-reviewed journal articles		**2012**
Malherbe J; Engelbrecht FA; Landman WA	Projected changes in tropical cyclone climatology and landfall in the Southwest Indian Ocean region under enhanced anthropogenic forcing	Climate Dynamics, Pages: DOI: 10.1007/s00382-012-1635-2 Dec 2012
Engelbrecht CJ; Engelbrecht FA; Dyson LL	High-resolution model-projected changes in mid-tropospheric closed-lows and extreme rainfall events over southern Africa	International Journal of Climatology, Pages: DOI: 10.1002/joc.3420 Jan 2012
Wokadala OC; Sinha Ray S; Naushad Emmambux MN	Occurrence of amylose-lipid complexes in teff and maize starch biphasic pastes	Carbohydrate Polymers, Vol. 90 (1), Pages: 616-622 Sep 2012
Obiro WC; Sinha Ray S; Emmambux MN	V-amylose structural characteristics, methods of preparation, significance, and potential applications	Food Reviews International, Vol. 28 (4), Pages: 412-438 Feb 2012
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Mashapa MG; Chetty N; Sinha Ray S	First principles studies of extrinsic and intrinsic defects in boron nitride nanotubes	Journal of Nanoscience and Nanotechnology, Vol. 12 (10), Pages: 7807-7814 Oct 2012
Ngobeni S; Venter H; Burke I	The modelling of a digital forensic readiness approach for wireless local area networks	Journal of Universal Computer Science, Vol. 18 (12), Pages: 1721-1740 Jun 2012
Das S; Gupta R; Kanda PT; Reid M; Tipoy CK; Zerihun MF	Real interest rate persistence in South Africa: evidence and implications	Economic Change and Restructuring, Pages: DOI: 10.1007/s10644-012-9132-5 Dec 2012
Van Heerden RP; Bester IM; Burke ID	A review of IPv6 security concerns	Journal of Information Warfare, Vol. 11(3), Pages: 25-28 Nov 2012
Masa J; Ozoemena K; Schuhmann W; Zagal JH	Oxygen reduction reaction using N4-metallomacrocyclic catalysts: fundamentals on rational catalyst design	Journal of Porphyrins and Phthalocyanines, Vol. 16 (7/8), Pages: 761-784 Aug 2012
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Das S; Gupta R; Kabundi A	Forecasting regional house price inflation: a comparison between dynamic factor models and vector autoregressive models	Journal of Forecasting, Vol. 30 (2), Pages: 288-302 Mar 2011
Joubert JW; Axhausen KW	Inferring commercial vehicle activities in Gauteng, South Africa	Journal of Transport Geography, Vol. 19 (1), Pages: 115-124 Jan 2011
Symes CT; McKechnie AE; Nicolson SW; Woodborne SM	The nutritional significance of a winter-flowering succulent for opportunistic avian nectarivores	Ibis, Vol. 153 (1), Pages: 110-121 Jan 2011
Du Plessis WP; Odendaal JW; Joubert J	Tolerance analysis of cross-eye jamming systems	IEEE Transactions on Aerospace and Electronic Systems, Vol. 47 (1), Pages: 740-745 Jan 2011
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O'Farrell PJ; De Lange WJ; Le Maitre DC; Reyers B; Blignaut JN; Milton SJ; Atkinson D; Egoh B; Maherry A; Colvin C; Cowling RM	The possibilities and pitfalls presented by a pragmatic approach to ecosystem service valuation in an arid biodiversity hotspot	Journal of Arid Environments, Vol. 75 (6), Pages: 612-623 Jun 2011
Thantsha MS; Guest J; Mputle I	Comparison of different methods for release of Bifidobacterium longum Bb46 from the poly(vinylpyrrolidone)-poly(vinylacetate-co-crotonic acid) interpolymer complex matrix, and the effect of grinding on the microparticles	World Journal of Microbiology and Biotechnology, Vol. 27, Pages: 2443–2448 Feb 2011
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Swanepoel JJ; van Vuuren DS; Heydenrych M	Leachability of nitrided ilmenite in hydrochloric acid	Journal of The Southern African Institute of Mining and Metallurgy, Vol. 111 (3), Pages: 137-140 Mar 2011
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Egoh BN; Reyers B; Rouget M; Richardson DM	Identifying priority areas for ecosystem service management in South African grasslands	Journal of Environmental Management, Vol. 92 (6), Pages: 1642-1650 Jun 2011

Authors	Title of publication	Publication
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Moleleki N; Wingfield MJ; Wingfield BD; Preisig O	Effect of Diaporthe RNA virus 1 (DRV1) on growth and pathogenicity of different Diaporthe species	European Journal of Plant Pathology, Vol. 131 (2), Pages: 261-268 Apr 2011
Denneman E; Wu R; Kearsley EP; Visser AT	Discrete fracture in high performance fibre reinforced concrete materials	Engineering Fracture Mechanics, Vol. 78 (10), Pages: 2235-2245 Jul 2011
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Duvenhage B; Bouatouch K; Kourie DG	Extending backward polygon beam tracing to glossy scattering surfaces	Computer Graphics Forum, Vol. DOI: 10.1111/j.1467-8659.2011.01903.x, Pages: 1-12 May 2011
Van Wyk E; Bean WL; Yadavalli VSS	Modelling of uncertainty in minimising the cost of inventory for disaster relief	South African Journal of Industrial Engineering, Vol. 22 (1), Pages: 1-11 May 2011
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Olivier K; Cilliers JE; Du Plessis M	Design and performance of wideband DRFM for radar test and evaluation	Electronics Letters, Vol. 47 (14), Pages: 824-825 Jul 2011
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Stamp J; Majozi T	Optimum heat storage design for heat integrated multipurpose batch plants	Energy, Vol. 36 (8), Pages: 5119-5131 Aug 2011

Karsten AE; Singh A; Braun MW	Experimental verification and validation of a computer model for light–tissue interaction	Lasers in Medical Science, Pages: 1-8 Apr 2011
Van Wilgen BW; Dyer C; Hoffmann JH; Ivey P; Le Maitre DC; Moore JL; Richardson DM; Rouget M; Wannenburgh A; Wilson RU	National-scale strategic approaches for managing introduced plants: insights from Australian acacias in South Africa	Diversity and Distributions, Vol. 17 (5), Pages: 1060-1075 Sep 2011
Tesfaye M; Sivakumar V; Botai J; Tsidu M	Aerosol climatology over South Africa based on 10 years of Multiangle Imaging Spectroradiometer (MISR) data	Journal of Geophysical Research: Atmospheres, Vol. 116, Pages: DOI: 10.1029/2011JD016023 Oct 2011
Adekola O; Majozi T	Wastewater minimization in multipurpose batch plants with a regeneration unit: multiple contaminants	Computers and Chemical Engineering, Vol. 35 (12), Pages: 2824-2836 Dec 2011
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Steyn W J vd M; Bean W; King D; Komba J	Evaluation of selected effects of pavement riding quality on logistics costs in South Africa	Transportation Research Record: Journal of the Transportation Research Board, Vol. 2227, Pages: 138-145 Dec 2011
Sibanda MM; Focke WW; Labuschagne FJWJ; Moyo L; Nhlapo NS; Maity A; Muiambo H; Massinga P; Crowther NAS; Coetzee M; Brindley GWA	Degradation of insecticides used for indoor spraying in malaria control and possible solutions	Malaria Journal, Vol. 10(307),12pp Oct 2011
Oranje M; Van Huyssteen E	Nestling national 'transformation' imperatives in local 'servicing' space: critical reflections on an intergovernmental planning and implementation project	Town and Regional Planning, Vol. 58, Pages: 6-16 Dec 2011

Authors	Title of publication	Publication
Peer-reviewed journal articles		**2011**
Madzivhandila VA; Majozi T; Zhelev TK	Recovery of flue gas energy in heat-integrated gasification combined cycle (IGCC) power plants using the contact economizer system	Energy & Fuels, Vol. 25 (4), Pages: 1529-1536 Mar 2011
Becker JVW; Van der Merwe MM; Van Brummelen AC; Pillay P; Crampton BG; Mmutlane EM; Parkinson C; Van Heerden FR; Crouch NR; Smith PJ; Mancama DT; Maharaj VJ	*In vitro* anti-plasmodial activity of Dicoma anomala subsp. gerrardii (Asteraceae): identification of its main active constituent, structure-activity relationship studies and gene expression profiling	Malaria Journal, Vol. 10 (295), 11pp Oct 2011
Engelbrecht FA; Landman WA; Engelbrecht CJ; Landman S; Bopape MM; Roux B; McGregor JL; Thatcher M	Multi-scale climate modelling over Southern Africa using a variable-resolution global model	Water SA, Vol. 37 (5), Pages: 647-658 Dec 2011
Fashedemi OO; Ozoemena KI	A facile approach to the synthesis of hydrophobic iron tetrasulfophthalocyanine (FeTSPc) nano-aggregates on multi-walled carbon nanotubes: a potential electrocatalyst for the detection of dopamine	Sensors and Actuators B: Chemical, Vol. 160 (1), Pages: 7-14 Dec 2011
Adekunle AS; Ozoemena KI; Mamba BB; Agboola BO; Oluwatobi OS	Supercapacitive properties of symmetry and the asymmetry of two electrode coin type supercapacitor cells made from MWCNTS/nickel oxide nanocomposite	International Journal of Electrochemical Science, Vol. 6, Pages: 4760-4774 Oct 2011
Adekunle AS; Ozoemena KI	Electrosynthesised metal (Ni, Fe, Co) oxide films on single-walled carbon nanotube platforms and their supercapacitance in acidic and neutral pH media	Electroanalysis, Vol. 23 (4), Pages: 971-979 Apr 2011
Maxakato NW; Mamuru SA; Ozoemena KI	Efficient oxygen reduction reaction using ruthenium tetrakis (diaquaplatinum) octacarboxyphthalocyanine catalyst supported on MWCNT platform	Electroanalysis, Vol. 23 (2), Pages: 325-329 Feb 2011

Authors	Title of publication	Publication
Chapter in book		**2012**
Harvey F; Iwaniak A; Coetzee S; Cooper AK	SDI past, present and future: a review and status assessment	Spatially Enabling Government, Industry and Citizens: Research and Development Perspectives, Pages: 23-38 May 2012
Von Maltitz GP; Sugrue A; Gush MB; Everson C; Borman GD; Blanchard R	Environmental and socioeconomic considerations for jatropha growing in Southern Africa	Socioeconomic and Environmental Impacts of Biofuels: Evidence from Developing Nations, Pages: 278-308 Mar 2012
Cooper AK; Coetzee S; Kourie DG	An assessment of several taxonomies of volunteered geographical information	Discovery of Geospatial Resources: Methodologies, Technologies, and Emergent Applications, Pages: 21-36 Apr 2012
Chetty A; Wepener I; Marei MK; Kamary YE; Moussa RM	Synthesis, Properties and Applications of Hydroxyapatite. InGshalaev VS, Demirchan AC, editors. Hydroxyapatite: Synthesis, Properties and Application. First ed. USA	Nova publishers, Pages: 1-40 Aug 2012
		2011
Mutombo K; Du Toit M	Corrosion fatigue behaviour of aluminium 5083-H111 welded using gas metal arc welding method	Arc Welding, Pages: 177-220 Dec 2011

Authors	Title of publication	Publication
Conference paper peer-reviewed		**2012**
Broich R; Grobler H	Analysis of the computational requirements of a pulse-doppler radar signal processor	2012 IEEE Radar Conference, Atlanta, Georgia, USA, 7-11 May 2012, Pages: 0835-0840 May 2012
Möller H; Govender G; Stumpf W	Factors influencing tensile mechanical properties of Al-7Si-Mg casting alloys A356/7	Light Metals Conference, USA, 11-15 March 2012, 5pp Mar 2012
Smith AC; Rapudi P; Setsiba K; Nkosi M; Mphalala N; Mpshe M; Phakula L	CorrectoSpecto: remote monitoring and controlling a patient's access to medication	IST-Africa 2012, Dar es Salaam, Tanzania, 9-11 May 2012, May 2012
Smith AC; Matshonyonga Z; Letsoko T; Mhlongo M; Msimanga LP; Kgosiemang KM	Towards managing consumer energy demand with the aid of the Internet of Things	IST-Africa 2012, Dar es Salaam, Tanzania, 9-11 May 2012, 10pp May 2012
Abu-Mahfouz AM; Steyn LP; Isaac SJ; Hancke GP	Multi-level infrastructure of interconnected testbeds of large-scale wireless sensor networks (MI2T-WSN)	2012 International Conference on Wireless Networks (ICWN'12) and 2012 World Congress in Computer Science Computer Engineering and Applied Computing, Las Vegas, Nevada, USA, July 2012, Pages: 445-450 Jul 2012
Sinvula KM; Coetzee S; Cooper AK	Contextualizing SDI theories and concepts in relation to the national spatial data infrastructure policy of Namibia	GISSA Ukubuzana 2012 Conference, Kempton Park, 2-4 October 2012, 9pp Oct 2012

Authors	Title of publication	Publication
Conference paper peer-reviewed		**2012**
Cooper AK; Coetzee S; Kourie DG	Assessing the quality of repositories of volunteered geographical information	GISSA Ukubuzana 2012 Conference, Kempton Park, 2-4 October 2012, 8pp Oct 2012
Gololo KV; Majozi T	Pressure drop consideration in cooling water systems with multiple cooling towers	11th International Symposium on Process Systems Engineering, Singapore, 15-19 July 2012, Jul 2012
Jansen van Rensburg GJ; Kok S; Wilke DN	Simultaneous estimation of experimental and material parameters	3rd International Conference on Engineering Optimization (EngOpt 2012), Rio de Janeiro, Brazil, 1-5 July 2012, 10pp Jul 2012
Wilke DN; Kok S	Numerical sensitivity computation for discontinuous gradient-only optimization problems using the complex-step method	10th World Congress on Computational Mechanics (WCCM 2012), Sao Paulo, Brazil, 8-13 July 2012, 12pp Jul 2012
Botha N; Kok S; Inglis HM	Intraocular pressure estimation using proper orthogonal decomposition	10th World Congress on Computational Mechanics (WCCM 2012), Sao Paulo, Brazil, 8-13 July 2012, 12pp Jul 2012
Jansen van Rensburg GJ; Kok S; Wilke DN	Material parameter identification on metal matrix composites	10th World Congress on Computational Mechanics (WCCM 2012), Sao Paulo, Brazil, 8-13 July 2012, 15pp Jul 2012
Batchelor J; Herselman M; Traxler J; Fraser W	Emerging technologies, innovative teachers and moral cohesion	IST-Africa 2012, Dar es Salaam, Tanzania, 9-11 May 2012, 9pp May 2012
Van Deventer M; Pienaar H	Employing the Moodle platform as a VRE Tool while teaching eResearch skills to Masters and PhD Students	4th International Conference on Education Technology and Computer (ICETC 2012), Cape Town, 19 August 2012, 5pp Aug 2012
Gonçalves D; De Vries M	Towards a force planning/design methodology	9th Annual INCOSE SA Conference 2012: Systems Engineering: The Jewel in the Crown, Pretoria, 27-29 August 2012, 18pp Aug 2012
Grobler TL; Ackermann ER; Van Zyl AJ; Kleynhans W; Salmon BP; Olivier JC	Sequential classification of Modis time series	IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Munich, Germany, 22-27 July 2012, 4pp Jul 2012
Sibiya G; Venter HS; Ngobeni S; Fogwill T	Guidelines for procedures of a harmonised digital forensic process in network forensics	International Workshop on Digital Forensics in the Cloud, Sandton, Johannesburg, 17 August 2012,7pp Sep 2012
Oosthuizen R; Pretorius L	Applying cognitive system engineering to cope with complexity in enterprises	9th Annual INCOSE SA Conference 2012: Systems Engineering: The Jewel in the Crown, Pretoria, 27-29 August 2012,16pp Aug 2012

Du Toit M; Letsoalo P; Möller H	Fusion welding of rheocast semi-solid metal (SSM) processed aluminium alloy 7017	12th International Conference on Semi-Solid Processing of Alloys and Composites, Cape Town, 8-11 October 2012, Oct 2012
Sibiya G; Venter HS; Fogwill T	Procedures for a harmonised digital forensic process in live forensics	Southern Africa Telecommunication Networks and Applications Conference (SATNAC 2012), George, South Africa, 2-5 September 2012,6pp Sep 2012
VdM Steyn WJ; Anochie-Boateng JK; Fisher C; Jones D; Truter L	Calibration of full-scale accelerated pavement testing data using long-term pavement performance data	4th International Conference on Accelerated Pavement Testing, Davis, California, 19-21 September 2012, Pages: 445-451 Sep 2012
Helbig M; Engelbrecht AP	Analyses of guide update approaches for vector evaluated particle swarm optimisation on dynamic multi-objective optimisation problems	IEEE World Congress on Computational Intelligence: IEEE Congress on Evolutionary Computation, Brisbane, Australia, 10-15 June 2012, Pages: 2621-2628 Jun 2012
McAlister BN; Steyn JL	New product development processes for ICT-for-development projects	Technology Management for Emerging Technologies (PICMET '12), Vancouver Canada, 29 July-2 August 2012, Pages: 3537-3548 Jul 2012
Salmon BP; Kleynhans W; Van den Bergh F; Olivier JC; Wessels KJ	Detecting land cover change by evaluating the internal covariance matrix of the extended Kalman filter	IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Munich, Germany, 22-27 July 2012, Jul 2012
Mentz J; Kotzé P; Van der Merwe A	A comparison of practitioner and researcher definitions of enterprise architecture using an interpretation method	Advances in Enterprise Information Systems II: Proceedings of the 5th International Conference on Research and Practical Issues of Enterprise Information Systems (Confenis 2011), Aalborg, Denmark, 15-18 October 2011, Pages: 11-26 Oct 2012
Kotzé P; Tsogang M; Van der Merwe A	A framework for creating pattern languages for enterprise architecture	Trends in Enterprise Architecture Research & Practice-Driven Research on Enterprise Transformation, Barcelona, Spain, 23-24 October 2012, 20pp Oct 2012
Naidoo R; Gerber A; Van der Merwe A	An exploratory survey of design science research amongst South African computing scholars	Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists (SAICSIT 2012), Centurion, South Africa, 1-3 October 2012, Pages: 335-342 Oct 2012
Gerber A; Sinha S; Van der Merwe A; Kam M	Accreditation of academic programmes in computing in South Africa	4th Software Engineering Colloquium, Cape Town, South Africa, 24 May 2012, 4pp May 2012

Authors	Title of publication	Publication
Conference paper peer-reviewed		**2012**
Kleynhans W; Salmon B	Monitoring informal settlements using SAR polarimetry	9th International Conference, African Association of Remote Sensing of the Environment (AARSE), Eljadida, Morocco, 29 October-2 November 2012, 6pp Oct 2012
Tack S; Burke M; Sinha S	Local exploration strategies for a mobile robot in a highly dynamic environment	5th Robotics and Mechatronics Conference of South Africa (ROBMECH 2012), Pretoria, 26-27 November 2012, 6pp Nov 2012
Pieterse H; Olivier MS	Android botnets on the rise: trends and characteristics	Information Security for South Africa (ISSA), Johannesburg, 15-17 August 2012, 5pp Aug 2012
Mouton F; Malan MM; Venter HS	Development of cognitive functioning psychological measures for the SEADM	6th International Symposium on Human Aspects of Information Security & Assurance, Crete, Greece, 6-8 June 2012, 12pp Jun 2012
Burke ID; Olivier MS	Fairness of trust based mobile *ad hoc* network protocols	7th International Conference on Information Warfare and Security, Seattle, USA, 22-23 March 2012,16pp Mar 2012
Bopape M; Engelbrecht F; Randall D; Landman W	Simulating moist convection with a quasi-elastic sigma coordinate model	28th Annual Conference of the South African Society of Atmospheric Sciences, Cape Town, 26-27 September 2012, Pages: 56-57 Sep 2012
Shatalov M; Manzhirov A; Fedotov I	On the resonant behavior of longitudinally vibrating accreting rods	8th South African Conference on Computational and Applied Mechanics (SACAM 2012), Johannesburg, South Africa, 3-5 September 2012, 5pp Sep 2012
Shatalov M; Fedotov I	Exact solutions and numerical simulation of longitudinal vibration of the Rayleigh-Love rods with variable cross-sections	8th South African Conference on Computational and Applied Mechanics (SACAM 2012), Johannesburg, South Africa, 3-5 September 2012, Sep 2012
Botha N; Kok S; Inglis HM	Finite element modeling of corneal strip extensometry	8th South African Conference on Computational and Applied Mechanics (SACAM 2012), Johannesburg, South Africa, 3-5 September 2012, Pages: 24-30 Sep 2012
Kloke KH; Joubert J; Odendaal JW	End-launched coaxial to partial H-plane waveguide adapter	2012 IEEE International Symposium on Antennas and Propagation and USNC-URSI National Radio Science Meeting, Guided Waves and Wave-Guiding Structures, Chicago, Illinois, USA , 13 July 2012, 1pp Jul 2012
Sibiya G; Venter HS; Fogwill T	Digital forensic framework for a cloud environment	IST-Africa 2012, Dar es Salaam, Tanzania, 9-11 May 2012, 8pp May 2012

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Smith AC; Springhorn H; Mulligan SB; Weber I; Norris J	tactusLogic: programming using physical objects	IST-Africa 2011 Conference, Gaborone, Botswana, 11-13 May 2011, 9pp May 2011
Möller H; Govender G; Stumpf WE	Comparison of the heat treatment response of wrought and SSM-HPDC alloy 6082	5th International Light Metals Technology Conference 2011 (LMT), Lüneburg, Germany, 19-22 July 2011, Vol. 690, Pages: 242-245 Jun 2011
Cooper AK; Rapant P; Hjelmager J; Laurent D; Iwaniak A; Coetzee S; Moellering H; Düren U	Extending the formal model of a spatial data infrastructure to include volunteered geographical information	25th International Cartographic Conference (ICC 2011), Paris, France, 4-8 July 2011, Jul 2011
Helbig M; Engelbrecht AP	Archive management for dynamic multi-objective optimisation problems using vector evaluated particle swarm optimisation	IEEE Congress on Evolutionary Computation (CEC 2011), New Orleans, USA, 5-8 June, 2011, Jun 2011
Coetzee S; Cooper AK; Ditsela J	Towards good principles for the design of a national addressing scheme	25th International Cartographic Conference (ICC 2011), Paris, France, 4-8 July 2011, Jul 2011
Suliman R; Oxtoby O; Malan AG; Kok S	Development of strongly coupled FSI technology involving thin walled structures	2nd African Conference on Computational Mechanics (AfriCOMP11), Cape Town, 5-8 January 2011, 3pp Jan 2011
Smit D; Herselman M; Eloff JHP; Ngassam E; Venter E; Ntawanga F; Chuang C-H; Van Greunen D	Formalising Living Labs to achieve organisational objectives in emerging economies	IST-Africa 2011 Conference, Gaborone, Botswana, 11-13 May 2011, May 2011
Cooper AK; Coetzee S; Kaczmarek I; Kourie DG; Iwaniak A; Kubik T	Challenges for quality in volunteered geographical information	AfricaGEO 2011: Developing Geomatics for Africa, Cape Town, South Africa, 31 May-2 June 2011, 13pp May 2011
Smith L; Oxtoby O; Malan AG; Meyer JP	Efficient modelling of aerodynamic flows in the boundary layer for high performance computing	2nd African Conference on Computational Mechanics (AfriCOMP11), Cape Town, 5-8 January 2011, 4pp Jan 2011
Van den Berg H; Coetzee S; Cooper AK	Analysing commons to improve the design of volunteered geographic information repositories	AfricaGEO 2011: Developing Geomatics for Africa, Cape Town, South Africa, 31 May-2 June 2011,12pp Jun 2011
Ditsela J; Coetzee S; Cooper AK	Proposed criteria for the evaluation of an address assignment scheme in Botswana	AfricaGEO 2011: Developing Geomatics for Africa, Cape Town, South Africa, 31 May-2 June 2011, 9pp Jun 2011
Möller H; Govender G; Stumpf WE	Comparison of the heat treatment response of SSM-HPDC 6082 and 6004 wrought alloys with A356 and F357 casting alloys	5th International Light Metals Technology Conference 2011 (LMT), Lüneburg, Germany, 19-22 July 2011, Pages: 53-56 Jun 2011
Grobler TL; Ackermann ER; Olivier JC; Van Zyl AJ	Systematic Luby Transform codes as incremental redundancy scheme	IEEE Africon 2011, Livingstone, Zambia, 13-15 September 2011 Sep 2011

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Conference paper peer-reviewed		**2011**
Ackermann ER; Grobler TL; Van Zyl AJ; Steenkamp KC; Olivier JC	Minimum error land cover separability analysis and classification of MODIS time series data	2011 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Vancouver, Canada, 24-29 July 2011, Jul 2011
Griffith DJ; Horlent M; Ibañez G; Lysko MD; Lubbe M; Mudau AE; Torrusio S; Sivakumar V; Vhengani LM	Vicarious calibration campaign in Argentina for radiometric calibration of a multispectral imager onboard Sumbandila Satellite	2011 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Vancouver, Canada, 24-29 July 2011, Pages: 993-996 Jul 2011
Fourie W; Barry M-L	Competency based career ladders for project managers in a large research and development organisation	International Research Network on Organising by Project Conference (IRNOP 2011), Montréal, Canada, 19-22 June 2011 Jun 2011
Ackermann ER; Grobler TL; Van Zyl AJ; Olivier JC	Belief propagation for nonlinear block codes	IEEE Africon 2011, Livingstone, Zambia, 13-15 September 2011, 6pp Sep 2011
Malherbe J; Engelbrecht FA; Landman WA; Engelbrecht CJ	Tropical systems from the southwest Indian Ocean making landfall over the Limpopo River Basin, southern Africa: a historical perspective	International Journal of Climatology, Vol. 32(7), Pages: 1018-1032 Mar 2011
Grobler M; Flowerday S; Von Solms R; Venter H	Cyber awareness initiatives in South Africa: a national perspective	1st IFIP TC9 / TC11 Southern African Cyber Security Awareness Workshop (SACSAW 2011), Gaborone, Botswana, 12 May 2011, 10pp May 2011
Burke ID; Van Heerden R; Olivier MS	Analysing the fairness of trust-based mobile *ad hoc* network protocols	10th Annual Information Security for South Africa Conference (ISSA 2011), Rosebank, South Africa, 15-17 August 2011, 8pp Aug 2011
Kleynhans W; Salmon BP; Olivier JC; Wessels KJ; Van den Bergh F	Comparison of feature extraction methods within a spatio-temporal land cover change detection framework	2011 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Vancouver, Canada, 24-29 July 2011, Jul 2011
Isaac SJ; Hancke GP; Madhoo H; Khatri A	A survey of wireless sensor network applications from a power utility's distribution perspective	IEEE Africon 2011, Livingstone, Zambia, 13-15 September 2011, 5pp Sep 2011
Grover AS; Van Huyssteen GB; Pretorius MW	A technology audit: the state of human language technologies (HLT) R&D in South Africa	Technology Management in the Energy-Smart World (PICMET 2011), Portland, Oregon, USA, 29 July-2 August 2011, Pages: 1963-1706 Jul 2011
Sivakumar V; Sharma A; Bollig C	Retrieval of atmospheric boundary layer height by CSIR NLC mobile LIDAR, Pretoria (25.5° S; 28.2° E), South Africa	2011 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Vancouver, Canada, 24-29 July 2011, Pages: 4115-4118 Jul 2011

Focke RW; Wabeke LO; de Villiers JP; Inggs MR	Implementing interval algebra to schedule mechanically scanned multistatic radars	14th International Conference on Information Fusion (FUSION 2011), Chicago, Illinois, USA, 5-8 July 2011, Pages: 1-7 Jul 2011
Oosthuizen R; Roodt JH; Pretorius L	Framework to investigate emergence in system engineering	International Conference on Industrial Engineering, Systems Engineering and Engineering Management for Sustainable Global Development, Stellenbosch, South Africa, 21-23 September 2011, 9pp Sep 2011
Matooane M; Garland RM; Engelbrecht F; Wright C; Olwoch J; Bopape M-J	Climate change and human health: oppressive temperatures in Southern Africa	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, 2pp Sep 2011
Meyers BC; Snedden GC; Meyer JP; Roos TH; Mahmood GI	Experimental results showing the internal three-component velocity field and outlet temperature contours for a model gas turbine combustor	20th International Symposium on Air Breathing Engines (ISABE 2011), Göteborg, Sweden, 12-16 September 2011, Pages: 1-15 Sep 2011
Ture K; Tsidu GM; Sivakumar V	Stratospheric ozone transboundary transport to upper troposphere North Africa	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, 2pp Sep 2011
Simpson L-A; Botai J; De Koning E; Sivakumar V	Comparing lightning polarity and cloud microphysical properties over regions of high ground flash density in South Africa	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, Sep 2011
Tesfaye M; Tsidu M; Sivakumar V; Botai J	Effective single scattering albedo estimation using regional climate model	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, 2pp Sep 2011
Luhunga P; Djolov G; Sivakumar V	A study of stable atmospheric boundary layer characterization over highveld region of South Africa	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, 2pp Sep 2011
Sivakumar V; Sharma A; Chiloane K; Naidoo S; Lynch E	CSIR NLC mobile lidar observation of cirrus cloud	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, 2pp Sep 2011
Andhavarapu EV; Loveday P; Long CS; Heyns PS	Accuracy of semi-analytical finite elements for modelling wave propagation in rails	7th South African Conference on Computational and Applied Mechanics (SACAM10), Pretoria, 10-13 January 2010, 13pp Jan 2011

Authors	Title of publication	Publication
Conference paper peer-reviewed		**2011**
Burke M; Bos N	Optimal placement of range-only beacons for mobile robot localisation	4th Robotics and Mechatronics Conference of South Africa (RobMech 2011), CSIR International Conference Centre, Pretoria, 23-25 November 2011, 6pp Nov 2011
Garland RM; Matooane M; Bopape MJ; Engelbrecht F; Naidoo M; Wright CY; Olwoch J	Climate change impacts on human health in South Africa	2011 National Association for Clean Air National Conference (NACA 2011), East London, South Africa, 13-14 October 2011, 5pp Oct 2011
Rakitianskaia AS; Olivier MS; Cooper AK	Nature and forensic investigation of crime in Second Life	10th Annual Information Security for South Africa Conference (ISSA 2011), Rosebank, South Africa, 15-17 August 2011 Aug 2011
Salmon BP; Kleynhans W; Van den Bergh F; Olivier JC; Marais WJ; Wessels KJ	Meta-optimization of the extended kalman filter's parameters for improved feature extraction on hyper-temporal images	2011 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), Vancouver, Canada, 24-29 July 2011, 4pp Jul 2011
De Vries M; Van der Merwe A; Kotze P; Gerber A	Using the interaction model to identify replication potential between business units	International Conference on Industrial Engineering, Systems Engineering and Engineering Management for Sustainable Global Development, Stellenbosch, South Africa, 21-23 September 2011, 14pp Sep 2011
De Vries M; Van der Merwe A; Kotze P; Gerber A	A method for identifying process reuse opportunities to enhance the operating model	2011 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM2011), Singapore, 6-9 December 2011, Pages: 1005-1009 Dec 2011
Adam R; Herselman M; Chuang C-H; Smit D; Eloff JHP; Zielinski MP	Challenges of evaluating a living lab in South Africa	Prato CIRN Community Informatics Conference, Prato, Italy, 9-11 November 2011, 10pp Nov 2011
Dlamini MT; Eloff MM; Eloff JHP; Venter HS	A budget model for information security	5th International Symposium on Human Aspects of Information Security and Assurance (HAISA 2011), London, 7-8 July 2011, Jul 2011
Modiba FS; Kotzé DA; Eloff J	The challenges of accessing information and communication technologies as indicated by women entrepreneurs in Pretoria, South Africa	6th International Conference on Interdisciplinary Social Sciences,, USA, 11-13 July 2011,10pp Jul 2011
Dlamini MT; Eloff JHP; Zielinksi MP; Chuang C; Smit D	User-centric information security systems: a living lab approach	10th European Conference on Information Warfare and Security (ECIW-2011), Tallinn, Estonia, 7-8 July 2011, 9pp Jul 2011
Bihina Bella MA; Olivier MS; Eloff JHP	Proposing a digital operational forensic investigation process	6th International Annual Workshop on Digital Forensics & Incident Analysis (WDFIA 2011), London, 7-8 July 2011, 11pp Jul 2011

Ngassam EK; Eloff JHP	A Web-Portal for accessing services by SMMEs in South Africa: A mashup prototype	IST-Africa 2011 Conference, Gaborone, Botswana, 11-13 May 2011, May 2011
Gerber MC; Gerber AJ; Van der Merwe AJ	Using formal ontologies for the development of consistent and unambiguous financial accounting standards	International Conference on Knowledge Engineering and Ontology Development, Paris, France, 26-29 November 2011, Pages: 419-424 Nov 2011
Venter CJ; Grobler H; AlMalki KA	Implementation of the CA-CFAR algorithm for pulsed-doppler radar on a GPU architecture	2011 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT), Amman, Jordan, 6-8 December 2011, 6pp Dec 2011
Bopape M-J; Engelbrecht F	Introducing a moisture scheme to a nonhydrostatic sigma coordinate model	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, 2pp Sep 2011
Willemse EJ; Joubert JW	Constructive heuristics for the residential waste collection problem	40th Annual Conference of the Operations Research Society of South Africa (ORSSA), Victoria Falls, Zimbabwe, 18-21 September 2011, Pages: 19-28 Sep 2011
Gerber MC; Gerber AJ	Towards the development of consistent and unambiguous financial accounting standards using ontology technologies	Accounting Renaissance: Lessons from the Crisis and Looking into the Future. Learning from Histories and Institutions, Venice, Italy, 4-5 November 2011,18pp Nov 2011
Albers PN; Wright C; Voyi K	The air the children of Witbank and Middelburg are breathing	2011 National Association for Clean Air National Conference (NACA 2011), East London, South Africa, 13-14 October 2011,5pp Oct 2011
Shatalov M; Fedotov I; Tenkam HM; Marais J	Comparison of classical and modern theories of longitudinal wave propagation in elastic rods	7th South African Conference on Computational and Applied Mechanics (SACAM10), Pretoria, 10-13 January 2010, 8pp Jan 2011
Smith L; Meyer JP; Oxtoby OF; Malan AG	An interactive boundary layer modeling methodology for aerodynamic flows	ASME 2011 International Mechanical Engineering Congress & Exposition (IMECE), Denver, Colorado, USA, 11-17 November 2011,11pp Nov 2011
Lazenby MJ; Landman WA; DeWitt DG	Seasonal maximum temperature prediction skill over southern Africa: 1- vs 2-tiered forecasting systems	27th Annual Conference of the South African Society for Atmospheric Sciences: the Interdependent Atmosphere, Land and Ocean, Hartbeespoort, 22-23 September 2011, 2pp Sep 2011
Van den Bergh WJ; Malan AG; Wilke DN	An algebraic multigrid solution strategy for efficient solution of free-surface flows	2nd African Conference on Computational Mechanics (AfriCOMP11), University of Cape Town, Cape Town, 5-8 January 2011, 4pp Jan 2011

CSIR researchers lecturing/ supervising students

Name of researcher	Type of collaboration	2011	2012	Research Area
Antony Cooper	Lecturing, supervising	•	•	Built environment
Prof Chrisna du Plessis	Lecturing, supervising	•		
Dr Erik Denneman	Lecturing, supervising	•		
Dr Jan Greben	Joint appointment	•		
Dr Morris de Beer	Lecturing, supervising	•	•	
Dr Dirk Conradie	Lecturing		•	
Dr Llewellyn van Wyk	Lecturing		•	
Dr Martin Mgangira	Moderation		•	
Dr Alize le Roux	Supervising		•	
Dr Pravesh Debba	External examining		•	
Dr Elsona van Huyssteen	External examining		•	
Dr Wim Jonker Klunne	Lecturing, examining		•	
Dr Tobias van Reenen	Lecturing		•	
Dr Peter Schmitz	Lecturing, supervising	•	•	
Dr Joseph Anochie- Boateng	Supervising	•	•	
Tinus Kruger	Supervising	•	•	
Dr Sonali Das	Lecturing, supervising	•	•	
Dheepak Maharaj	Supervising	•	•	Biosciences
Lucia Steenkamp	Lecturing		•	
Dr Petrus van Zyl	Supervising	•	•	
Dr Rachel Chikwamba	Lecturing, supervising	•	•	
Dr Michael Crampton	Supervising	•	•	
Dr Ereck Chakauya	Supervising	•	•	
Dr Makobetsa Khati	Supervising	•	•	
Dr Musa Mhlanga	Supervising	•	•	
Dr Wilhelm Richter	Supervising	•	•	
Dr Yolandy Lemmer	Supervising		•	
Kevin Land	Supervising	•	•	
Dr Bennie Broughton	Lecturing, supervising	•		Defence and security
Dr Glen Snedden	Supervising	•		
Nelis Williers	Lecturing, supervising	•	•	
Dr Warren du Plessis	External examining	•	•	
Jacques Cilliers	Supervising, examining	•	•	
Arnaud Malan	Supervising	•	•	
Prof Schalk Kok	Supervising			
Dr Aurona Gerber	Lecturing, supervising	•	•	ICT
Dr Barend Taute	Lecturing	•	•	
Dr Bruce Becker	Supervising	•	•	
Chris Burger	Supervising	•		
Dr Adnan Abu-Mahfouz	Lecturing, examining		•	
Dr Andrew Smith	Supervising		•	

Dr Daniel Moeketsi	Examining		•	ICT
Graeme McFerren	Supervising, lecturing		•	
Dr Kevin Colville	Lecturing		•	
Dr Waldo Kleynhans	Lecturing		•	
Dr Febe de Wet	Supervising	•	•	
Dr Frans van den Bergh	Supervising	•	•	
Jan Eloff	Lecturing, supervising	•		
Dr Keith Ferguson	Lecturing	•		
Dr Konrad Wessels	Lecturing, supervising	•	•	
Dr Louis Coetzee	Supervising	•		
Dr Marelie Davel	Supervising	•	•	
Mario Marais	Examining	•	•	
Thomas Fogwill	Supervising	•	•	
Busisiwe Vilakazi	Supervising		•	
Prof Marthie Grobler	Supervising	•		
Dr Pieter de Villiers	Supervising	•	•	
Dr Marlien Herselman	Supervising	•	•	
Philip Frost	Supervising	•		Materials science and manufacturing
Dr Boitumelo Semete	Lecturing, supervising	•	•	
Dr Suretha Potgieter	Supervising		•	
Dr Bonex Mwakikunga	Supervising		•	
Lonji Kalombo	Supervising		•	
Dr Philip Loveday	Supervising		•	
Dr Hilda Chikwanda	Supervising	•	•	
Dr Dawie van Vuuren	Supervising	•	•	
Dr Suprakas Sinha Ray	Supervising	•	•	
Dr Kenneth Ozoemena	Supervising	•	•	
Prof Schalk Kok	Lecturing, supervising	•		Modelling and digital science
Dr Onno Ubbink	Lecturing, supervising	•		
Dr Donald Mkhonto	Supervising	•		
Fred Senekal	Examining	•		
Natasha Govender	Examining	•		
Aletta Karsten	Lecturing	•		Photonics
Dr Siva Venkataraman	Lecturing, supervising	•		
Dr Stef Roux	Lecturing	•		
Dr Alan Brent	Lecturing, supervising	•	•	Natural environment
Dr Bob Scholes	Supervising, lecturing	•	•	
Dr Caradee Wright	Supervising	•	•	
Dr Lorren Haywood	Lecturing, supervising	•	•	
Dr Pete Ashton	Lecturing, supervising, examining	•	•	
Dr Russel Wise	Supervising	•	•	
Dr Phil Paige-Green	Supervising	•		
Dr Francois Engelbrecht	Supervising	•	•	
Dr Njabulo Siyakatshana	Supervising	•	•	
Dr Tammy Bush	Supervising	•	•	
Dr Willem de Lange	Supervising	•	•	

CSIR staff studying

CSIR staff	CSIR supervisor	UP supervisor	Degree programme	2011	2012
Siphethile Gcukumana	None	Marietjie Schutte	BA (Honours) (Information Science)	•	•
Basanda Pongoma	None	None	BSc (Honours) (Technology Management)		•
Riaan Bergh	None	Prof Herman Steyn	MEng (Engineering Management)	•	•
Pranitha Dawlal	None	Prof Elna Buys; Dr Mapitsi Thantsha	PhD (Microbiology)		•
Tshidi Moroka	None	Prof Andre Oelofse	MSc (Nutrition)		•
Claire Rossouw	Dr Kenneth Ozoemena	Dr Kenneth Ozoemena	PhD (Chemistry)*		•
Mpho Mamabolo	Dr Michael Crampton	Prof Jacques Theron	PhD (Microbiology)	•	•
Mulalo Nemutanzhela	Dr Rachel Chikwamba	Dr Bridget Crampton; Dr Sanushka Naidoo	MSc (Biotechnology)*	•	•
Obakeng Maema	Dr Ereck Chakauya	Dr Rachel Chikwamba	MSc (Biotechnology)	•	•
Tinyiko Mokoena	Dr Ereck Chakauya	Dr Rachel Chikwamba	PhD (Molecular Plant Physiology)	•	•
Lia Rotherham	Dr Makobetsa Khati	Prof Jacques Theron	PhD (Microbiology)*	•	•
Fungai Mandikuwaza	None	Lizette Weilbach	MSc (Information Technology)*	•	
Ntshumi Mbekwa	None	Henk Pretorius	BCom (Honours) (Informatics)	•	•
Bryan Mcalister	None	Prof Jasper Steyn	MEng (Technology Management)*	•	
Thipe Modipa	Prof Marelie Davel	Prof Marelie Davel	PhD (Electronics)#	•	
Tshepo Moganedi	None	None	BSc (Honours) (Computer Science)	•	
George Sibiya	Thomas Fogwill	Prof Hein Venter	PhD (Computer Science)	•	•
Gugu Khalala	None	Prof Awie Leonard	BCom (Honours) (Informatics)*	•	•
Cleophas Dzinotyiweyi	None	Prof Leon Pretorius	MSc (Project Management)*	•	•
Ronel Smith	None	Dr Rennie Naidoo	PhD (Informatics)		•
Adnan Abu-Mahfouz	None	Dr Gerhard Hancke	PhD (Computer Engineering)*	•	

Marde Helbig	None	Prof Andries PetrusEngelbrecht	PhD (Computer Science)*	•	•
Ken Mkhabela	None	None	BEng (Honours) (Structural Engineering)*	•	•
Naalamkai Ampofo-Anti	None	Prof Piet Vosloo	M (Architecture)	•	•
Nhlanhla Dlamini	None	None	BEng (Honours) (Structural Engineering)*	•	•
Sihle Dlungwana	None	None	BSc (Honours) (Technology Management)*	•	
		Prof Chrisna du Plessis	MSc (Technology Management)		•
Lorato Motsatsi	None	Prof Piet Vosloo	M (Architecture)		•
Amy Maharaj	Dr Phil Paige-Green	Prof Louis van Rooy	MSc (Geological Engineering)	•	
Johan O'connell	None	None	BSc (Honours) (Transport Planning)*	•	•
Julius Komba	Dr Joseph Anochie-Boateng	Prof Wynand Steyn	MEng (Transportation Engineering)	•	•
Matsopole Nkgapele	None	None	BEng (Honours) (Technology Management)		•
Sizo Sebake	Tinus Kruger	Ida Breed	MSc (Applied Science)	•	•
Wilna Bean	None	Prof Johan Joubert	MEng (Industrial Engineering)	•	
Zamaswazi Nkuna	None	Prof Hannes Rautenbach	MSc (Water Resources Management)	•	•
Shanna Nienaber	None	Prof Anton du Plessis	MA (International Relations)	•	•
Jino Mundackal	Dr Caradee Wright	Prof Petro Terblanche; Dr Janine Wichmann	MSc (Community Health)	•	•
Mary-Jane Bopape	Dr Francois Engelbrecht	Prof Willem Landman	PhD (Meteorology)	•	•
Aletta Karsten	None	Prof Max Braun	PhD (Physics)	•	•
Chris Mahlathi	Dr Njabulo Siyakatshana	Prof Evans Chirwa	MEng (Water Engineering)	•	•
Jaco Jansen van Rensburg	None	Dr Nico Wilke; Prof Schalk Kok	PhD (Mechanical Engineering)		•
			MSc (Mechanical Engineering)*	•	
Michaela Beckley	Busisiwe Vilakazi	Prof Schalk Kok	BSc (Honours) (Applied Science)		•
Mpume Basi	Dr Donald Mkhonto	Prof Nithaya Chetty	MSc (Physics)		•

Natasha Botha	Prof Schalk Kok	Helen Inglis	MEng (Mechanical Engineering)*	•	•
Nicolin Govender	None	Dr Nico Wilke; Prof Schalk Kok	PhD (Applied Science)		•
Vincent Gololo	None	Prof Thokozani Majozi	PhD (Chemical Engineering)*	•	•
Louis van Wyk	None	None	MSc (Engineering Management)		•
Neall Moore	None	None	BEng (Honours) (Mechanical Engineering)*	•	•
Ridhwaan Suliman	Arnaud Malan; Prof Schalk Kok	Josua Meyer	MEng (Mechanical Engineering)*	•	•
Eugene Gous	Cobus Venter	None	MEng (Engineering Management)	•	•
Heloise Pieterse	None	Prof Martin Olivier	MSc (Computer Science)		•
Hildegarde Koen	Dr Pieter de Villiers	Dr Pieter de Villiers	PhD (Electronics)	•	•
Jaco Meintjes	None	None	BEng (Honours) (Computer Engineering)*	•	•
Neeshal Munga	None	Prof Martin Olivier	M (Information Technology)	•	•
Peter Chan	Prof Marthie Grobler	Prof Martin Olivier	MSc (Computer Science)	•	•
Priaash Ramadeen	Dr Pieter de Villiers	Dr Pieter de Villiers	BEng (Honours) Computer Engineering*	•	•
Rudolph Oosthuizen	None	Prof Leon Pretorius	PhD (Engineering Management)	•	•
Shazia Vawda	None	None	BSc (Honours) (Computer Science)*	•	•
Sifiso Simelane	None	None	BEng (Honours) Technology Management#		•
Sipho Ngobeni	None	Prof Hein Venter	MSc (Computer Science)	•	•
Zama Dlamini	None	Prof Martin Olivier	MSc (Computer Science)	•	•
Caron Griffiths	Dr Musa Mhlanga	Dr Lynnaie Birkholtz	MSc (Biochemistry)*	•	•
Carel Combrink	None	None	BEng (Honours) (Computer Engineering)*	•	•
Celma Kitching	None	Dr Warren du Plessis	MEng (Electronic Engineering)	•	•
Chris Venter	None	Hans Grobler	MEng (Computer Engineering)	•	•
Christo Fourie	None	Prof David Walwyn	MEng (Engineering Management)		•

Reeshen Reddy	None	Prof Saurabh Sinha	MEng (Micro-Electronic Engineering)*	•	•
Rene Broich	None	Hans Grobler	MEng (Electronic Engineering)*	•	•
Hendrik Theron	None	Prof Nico Theron	MEng (Mechanical Engineering)		•
Ipeleng Mathebula	None	Prof Joshua Meyer	MEng (Mechanical Engineering)*	•	•
Ryno Van Staden	None	Johan Schoeman	BEng (Honours) Electronic Engineering)*		•
Nivan Moodley	None	Prof Dave Walwyn	MSc (Technology Management)	•	•
Roger Young	None	Dr Richard Weeks	MEng (Engineering Management)	•	•
Piet Ramaloko	None	Prof Andre Buys	MEng (Engineering Management)*	•	•
Tleyane Sono	None	Prof David Walwyn	MSc (Project Management)*		•
Walrich Grundling	None	None	BEng (Honours) Mechanical Engineering)*	•	
Anria Strydom	None	Prof Schalk Els	MEng (Mechanical Engineering)	•	•
Inus Grobler	None	Prof Michael Njoroge Gitau	PhD (Electrical & Electronic Engineering)	•	•
Werner Wortmann	None	None	BEng (Honours) (Electronic Engineering)*	•	
		Prof Gerhard Hancke	MEng (Telecommunications Engineering)		•
Charl Jafta	Dr Kenneth Ozoemena	Prof Ncholu Manyala	PhD (Physics)		•
Andri Barnard	None	None	BEng (Honours) (Chemical Engineering)*	•	
Avashnee Chetty	None	Prof Walter Focke	PhD (Chemical Technology)*	•	•
Ilse Wepener	Dr Wim Richter	Prof Anna Joubert	PhD (Physiology)	•	•
Vincent Mandla Khumalo	None	None	BSc (Honours) (Polymer Chemistry)#	•	•
Lindokuhle Ndlandla	Dr Yolandy Lemmer	Prof Jan Verschoor	PhD (Biochemistry)		•
Linda Mahlatji	Dr Hilda Chikwanda	Prof Waldo Stumpf	MEng (Metallurgical Engineering)	•	•
Mandy Seerane	Dr Hilda Chikwanda	Prof Walter Focke	BEng (Honours) Metallurgy		•

Jabu Skosana	Dr Dawie van Vuuren	Prof Mike Heydenrych	MEng (Chemical Engineering)	•	•
Shaan Oosthuizen	None	Dr Alex Antonites	MPhil (Entrepreneurship)*	•	
Hein Moller	None	Prof Waldo Stumpf	PhD (Metallurgical Engineering)*	•	
Kalenda Mutombo	None	Prof Waldo Stumpf	PhD (Metallurgical Engineering)	•	•
Levy Chauke	None	Prof Andrie Garbers-Craig	MSc (Materials Engineering)*	•	•
Dawid Oosthuizen	None	Anne Crafford	MEng (Engineering Management)		•
Shavon Kumar	Kevin Land	Prof Jan Verschoor	MSc (Biotechnology)	•	•
Malcolm Govender	Dr Bonex Mwakikunga	Prof Herbert Willie Kunert	PhD (Physics)		•
Matete Mashapa	Dr Suprakas Sinha Ray	Prof Nitaya Chetty	PhD (Physics)	•	•
Eddie Williams	Dr Philip Loveday	Prof Nico Theron	MEng (Mechanical Engineering)	•	•
Deon Joubert	None	Dr Hans Grobler	MEng (Electronic Engineering)	•	•

*= Graduated # = left CSIR/ no longer studying at UP

CSIR Bursars

Name of CSIR staff	Degree programme	2011	2012
Marlise Cowley	BEng (Mechanical Engineering)		•
Nokuthula Nzimande	BEng (Mechanical Engineering)		•
Pfarelo Daswa	BEng (Metallurgical Engineering)	•	•
Uma Vijayan	BEng (Chemical Engineering)		•
Calvin Phendola	BEng (Electronic Engineering)		•
Chane Horn	BEng (Electronic Engineering)		•
Mayur Tikam	BEng (Mechanical Engineering)		•
Nonofo Mogoshane	BSc (Honours) (Computer Science)		•
Aubrey Nyelele	BSc (Computer Science)		•
Phuti Ledwaba	BEng (Civil Engineering)		•
Lana Kemp	BEng (Civil Engineering)		•
Zanele Betty Maluleka	BSc (Mathematical Science)	•	•
Katiso Mogale	BEng (Industrial Engineering)	•	•
Janine Versteegh*	BEng (Honours)(Mechanical Engineering)	•	•
Jaco van der Bergh	BEng (Computer Engineering)	•	•
Christina Turner*	BEng (Civil Engineering)	•	•
David Diamond*	BEng (Mechanical Engineering)	•	•
Tsholofelo Letsoko	BCom (Honours) (Informatics)	•	•
Ron Phillip	BEng (Electronic Engineering)	•	•
Amy Beukes	BSc (Town and Regional Planning)	•	•
Ciara Pienaar	BEng (Electronic Engineering)	•	•
Monique Pienaar	BEng (Electronic Engineering)	•	•
Dineo Anna Mary Ramatlo	BEng (Mechanical Engineering)	•	•
Richardt Benade	BEng (Mechanical Engineering)	•	•
Isaac Itumeleng Setshedi	BEng (Mechanical Engineering)	•	•
Petrone Bezuidenhout	BEng (Electronic Engineering)	•	•
Anitha Zikhona Eyethu Lilitha Madikizela	BEng (Chemical Engineering)	•	•
Rossouw van der Merwe*	BEng (Electronic Engineering)	•	•

Elsmari Wium	BEng (Mechanical Engineering)	•	•
Daniel Schoeman	BEng (Electronic Engineering)	•	•
Nonhlanhla Florence Mkwanazi	BSc (BIS Multi Media)	•	
Keamogetse Mohlala*	BSc (Honours) (Microbiology)	•	
Thandiwe Girls Mphuti*	BEng (Aeronautical Engineering)	•	
Johannes Hattingh*	BEng (Honours) (Electronic Engineering)	•	
Neall Moore*	BEng (Mechanical Engineering)	•	
Heloise Pieterse*	BSc (Honours) (Computer Science)	•	
Ndunisani Precious Mongwe*	BSc (Honours) (Chemistry)	•	

= Graduated

CSIR staff holding extraordinary appointments

Name of Researcher	Area of expertise	2011	2012
Dr Pete Ashton	Water ecosystems	•	•
Dr Willem Landman	Seasonal forecasting	•	•
Dr Colin Kenyon	Structural biology	•	•
Dr Kenneth Ozoemena	Fuel cells	•	•
Dr Hein Moller	Alloying & processing	•	•
Dr Frans van den Bergh	Remote sensing	•	•
Dr Marius Claassen	Water ecosystems	•	•
Dr Konrad Wessels	Earth observation	•	•
Dr Waldo Kleynhans	Earth observation		•
Dr Rachel Chikwamba	Molecular biology	•	•
Dr Liesbeth Botha	Serving on UP Council	•	•

UP staff serving on CSIR advisory panels

Name of Staff	Area of Research Expertise	2011	2012
Dr Chris Theron	Solid state physics	•	•
Prof Dave Morgan	Surface chemistry and engineering of industrial compounds	•	•
Prof Jasper Steyn	Mathematics education	•	•
Prof Stephan Heyns	Structural dynamics and vibrations	•	•
Prof Elsabe Kearsley	Cement and concrete materials	•	•
Prof Karel Bakker	Architecture	•	•

NRF-rated researchers*
(Science and engineering only)

Name	Research specialisations
Leading international researcher	
UP	
Prof NC Bennett	Animal physiology, Sociobiology, Comparative physiology, Animal reproduction
Prof B Rand	Carbon materials, Carbon and Graphite Materials
Prof X Xia	Energy modelling, Automation and control, Energy management, Energy efficiency
Prof MJ Wingfield	Plant pathology, Mycology
Prof RP Millar	GPCR, G-protein coupled receptor, Biochemistry, Endocrinology, Chemical pathology, Neuroendocrinology, Reproduction
Prof DA Cowan	Microbial ecology, Metagenomics, Microbial enzymes
CSIR	
Prof RJ Scholes	Systems ecology, Natural resources and enviroment, Biogeochemistry, Earth observation, Savanna ecology, Global change

*= Definitions on p.81

Name	Research specialisations
Internationally acclaimed researcher	
UP	
Prof W Altermann	Precambrian geology, Bio-geology, Sedimentology, Sedimentary ore deposits
Prof R Anguelov	Computational mathematics, Numerical analysis, Nonlinear partial diff. equation, Partial differential equations, Interval analysis, Finite difference methods
Dr PB Best	Wildlife - Reproduction, Marine mammalogy, Population dynamics, Monitoring - Wildlife populations
Prof MN Bester	Seals, Behavioural ecology, Population ecology, Foraging ecology, Marine vertebrates
Prof FD Auret	Defects in semiconductors, Wide bandgap semiconductors, Compound semiconductors, Thin film technology, Semiconductor devices, Semiconductor characterization
Prof TA Coutinho	Plant pathology, Mycology, Forestry
Prof IK Craig	Control systems, Automation and control, Mineral processing, Economic analysis, Control engineering, Advanced process control
Prof CJ Botha	Veterinary toxicology
Prof JCA Boeyens	Applied number theory, Theoretical chemistry, Symmetry, Bohmian mechanics, Molecular shape, Matter cycles, Atomic structure, Superconductivity, Chirality, Nuclides
Prof JN Blignaut	Environmental resource economics, Development economics, Environmental economics, Macroeconomics
Prof SG Burton	Biotechnology, Environmental bioprocesses, Biocatalysis, Bioremediation, Bioprocesses, Biocatalysis, Enzymology, Biotransformations, Biotechnology, Bioremediation
Prof RM Crewe	Apoidea (Bees), Social insects, Population genetics, Behavioural ecology
Prof M Du Plessis	Microelectronics
Prof AP Engelbrecht	Artificial intelligence, Data mining, Neural networks, Evolutionary computation, Swarm intelligence, Robotics, Image analysis
Prof IG Horak	Veterinary parasitology, Ticks, Helminthology
Prof JHP Eloff	Information security, Computer security, Information security governance
Prof JN Eloff	Phytomedicine, Antibacterial compounds, Antifungal drugs, Drugs from plants, Phytopharmacology, Drug testing - Plants, Herbal medicine, Animal biotechnology, Agricultural biotechnology, Animal health
Prof JM Greeff	Behavioural ecology, Evolutionary ecology, Evolutionary biology
Prof M Sango	Geometric analysis, Partial differential equations, Stochastic differential equations, Nonlinear partial diff. equation
Prof L Korsten	Postharvest pathology, Food safety, Plant pathology, Microbial ecology, Biological control
Prof T Majozi	Process integration, Batch processes
Prof GT Fosgate	Brucellosis diagnostics and epidemiology, Paratuberculosis diagnostics and epidemiology, Analytical epidemiology, Diagnostic test validation
Prof AWH Neitz	Agricultural sciences, Biological sciences, Animal science, Molecular sciences, Veterinary science
Prof BD Wingfield	Genomics, Phylogenomics, Fungal biodiversity, Fungal genetics, Fungal disease diagnostics, Fungal molecular biology, Fungal population biology, Fungal viruses, Phylogenetics, Population genetics
Prof AE van Wyk	Anatomy (Plants), Biogeography, Angiosperms, Systematics, Biodiversity, Palynology
Prof CH Scholtz	Biosystematics

Prof AL Michel	Mycobacterial diseases, Zoonoses
Prof SA Rakitianski	Quantum scattering, Theory of quantum resonances, Theoretical nuclear physics, Theoretical physics, Quantum few-body theory
Prof M Steyn	Skeletal biology, Forensic anthropology, Bioarchaeology, Forensic archaeology, Skeleton, Human and primate anatomy
Prof LH Nel	Molecular epidemiology, Rabies, Virology, Animal virology, Zoonoses, Virus diagnosis, Veterinary biotechnology, Viral vaccines, Virus epidemiology
Prof JRN Taylor	Cereal science
Prof W Nicol	Reaction engineering
Prof JP Schoeman	Endocrinological response to infectious disease, Veterinary Internal Medicine
Prof JM-S Lubuma	Applied mathematics, Application of mathematics, Dynamical systems, Finite element methods, Numerical analysis, Partial differential equations, Ordinary differential equations - Numerical methods, Function spaces, Finite difference methods, Boundary elements methods
Prof EE Rosinger	Differential equations, Functional analysis, Numerical analysis, Lie groups, Operations research, Physics, Topology
Prof J Roux	Forest pathology, Mycology, Fungal population biology
Prof PG Eriksson	Sedimentology, Basin analysis
Prof ER Rohwer	Analytical chemistry, Chromatography, Instrumentation, Mass spectrometry, Laser spectroscopy
Prof RM Kirberger	Radiology and ultrasound of small animals and wildlife, Computed tomography
Prof JF Kirsten	Institutional economics, Land reform, Food marketing, Agricultural policy
Prof RM Hassan	Environmental and resource economics, Ecological economics, Agricultural economics
Prof S Lotz	Liquid crystals, Advanced materials, Metal-mediated reactions, Anti-cancer drugs, Inorganic synthesis, Organometallic catalysts, Organometallic chemistry, Catalysis (Homogeneous)
Prof AI Louw	Protein structure-function relationship, Malaria, Antimalarial compounds, Genomics, Protein metabolism, Proteins - Characterisation, Protein biochemistry, Protein expression, Protein structure
Prof SW Nicolson	Pollination biology, Ecophysiology
Prof RC Pattinson	Child health, Health systems, Maternal health
Prof BL Penzhorn	Parasitology, Wildlife medicine
Prof J Joubert	Antennas, Microwave filters, Microwave communication systems - Engineering, Antennas, Electrogmagnetics and antenna arrays
Prof JW Odendaal	Compact ranges, Antennas and radiation
Prof JB Malherbe	Materials Science, Surface physics, Nuclear solid state physics, Surface science, Materials characterization, Ion-solid interactions, Nuclear materials
Prof JJM Meyer	Pharmaceutical sciences, Pharmaceutical chemistry, Plant Sciences, Ethnobotany, Ethnopharmacology, Natural products from plants
Prof JP Meyer	Heat transfer, Thermal sciences, Evaporation, Thermodynamics, Heat exchangers, Energy, Computational heat transfer, Computational fluid dynamics, Refrigeration, Condensation
Prof AA Myburg	Forest genetics, Molecular genetics
Prof AE McKechnie	Ornithology, Evolutionary physiology, Comparative physiology, Stable light isotopes
Prof WJvdM Steyn	Pavement engineering, Vehicle pavement interaction, Materials science infrastructure development, Road pavement materials, Accelerated pavement testing, Pavement engineering, Pavement maintenance and rehabilitation

CSIR	
Dr KI Ozoemena	Cyclic voltammetry, Electrochemistry, Electrochemical research, Photoelectrochemistry, Electrocatalysis, Electrochemical sensors, Electrochemical synthesis, Fuel cells, Battery chemistry, Energy storage
Prof B Reyers	Ecosystem services, Conservation ecology, Applied ecology
Prof SSR Sinha Ray	Nanostructured materials
Dr BW van Wilgen	Invasion biology, Fire ecology, Fire management, Invasive alien plants, Fire ecology, Adaptive management of complex ecosystems
Prof TA Meyer	Computer science, Information technology, Logic, Artificial intelligence, Ontologies
Dr PMS Monteiro	Marine biogeochemistry
Prof A Forbes	Optics and lasers, Quantum physics, Applied physics
Prof P Kotze	Socio-technical systems, Computer science, Enterprise engineering, Human factors engineering, Design Research, Enterprise architecture, Industrial engineering, Enterprise Architecture, Information technology, Information and knowledge management, Human-computer interaction
Dr WA Landman	Forecast system development, Downscaling, Weather and climate variability

Surname	Research specialisations
Established researcher	
UP	
Prof C Abolnik	Genomics, Molecular evolution, Molecular epidemiology, Veterinary diagnostics, Veterinary virology, Veterinary epidemiology
Prof PM Alexander	Information systems - Management, Change Management, Computer aided instruction, Management information systems, ICT career choice, Computer education, Information systems in a social context
Prof JG Annandale	Soil water - Modelling, Crops - Water requirements, Irrigation - Management, Irrigation water - Quality
Prof Z Apostolides	Bioinformatics, Toxicology, Antioxidants, HIV therapeutics
Prof TAS Aveling	Sustainable agriculture, Smallholder agriculture, Mycotoxins, Plant pathology, Seed science, Seed pathology, Soilborne plant diseases, Plant disease control, Electron microscopy, Indigenous plants, Pathogens
Prof OA Ayo-Yusuf	Tobacco control, Public oral health
Prof KA Bakker	Culture conservation, Architecture - Conservation and restoration, Urban conservation, Architecture - Theory
Prof ADS Bastos	Molecular phylogenetics and systematics, Infectious diseases of wildlife, Molecular epidemiology, Molecular diagnostics
Prof A Bekker	Distribution theory, Distribution (Probability theory)
Prof DK Berger	Molecular plant pathology, Bioinformatics
Prof P Bloomer	Population genetics, Phylogenetics, Biogeography, Conservation genetics, Biodiversity conservation, Phylogeography
Prof MS Bornman	Toxicology, Endocrine disruptors, Environmental pathology, Genito-urinary diseases (incl. Urology)
Prof GJ Bredenkamp	Vegetation science, Veld ecology, Veld management, Wildlife management, Plant ecology, Botany
Prof AJ Bumby	Structural geology

Prof AJ Buys	Technology policy
Prof EM Buys	Food safety, Dairy
Prof NH Casey	Animal physiology, Animal production
Prof CT Chimimba	Biostatistics, Biosystematics, Mammalogy, Nature conservation
Prof EMN Chirwa	Environmental biotechnology, Water - Environmental biotechnology, Environmental modelling, Environmental microbiology, Environmental engineering
Prof PWC Chirwa	Agroforestry, Community forestry, Forests and forestry - Social aspects, Forests and forestry - Research, Soil fertility, Soil water relations
Dr SM Coetzee	Geographical information systems, Web Services, World-Wide Web services, International Organization for Standardization (ISO), Geoinformatics, Standards, Geo-Informatics
Dr NE Collins	Molecular parasitology, Molecular characterisation, Molecular diagnostics, Genomics
Prof PL Crouse	Materials processing
Prof I Cukrowski	Electrochemistry, Theoretical chemistry, Metal complexes, Computational chemistry
Prof C de Jager	Public health, Public health intervention, Reproductive health, Endocrine disrupting chemicals, Malaria control, Environmental Epidemiology
Prof HL de Kock	Sensory analysis, Meat science
Prof C de Villiers	Education - Information technology, E-learning
Dr JDK Djoko Kamdem	Applied Functional Analysis, Numerical analysis, Partial differential equations
Prof ASA du Toit	Knowledge management, Competitive intelligence, Information management
Prof ES du Toit	Sustainable agriculture, Agricultural biotechnology, Plant production, Horticulture
Prof M du Toit	Alloy development, Failure analysis
Dr KG Duodu	Food chemistry
Dr RDEV Duvenhage	Noncommutative, Dynamical systems
Prof MM Ehlers	Applied molecular diagnostics, HIV and Tuberculosis, Mycobacterium tuberculosis, Multidrug resistant tuberculosis, Medical microbiology, Antibiotic resistance - Prevalence, Antibiotic resistance mechanisms, Infection control, Zoonotic diseases, Medical microbiology, Activated sludge - Microbiology
Prof PS Els	Vehicle dynamics, Vehicle testing, Vehicle-pavement interaction, Multibody dynamics
Prof LJ Erasmus	Ruminant nutrition, Dairy cattle feeding and management, Feed additives, Biological models for dairy cows
Prof JWH Ferguson	Evolutionary ecology
Prof WW Focke	Chemical Engineering
Prof EKH Friedland	Ion beam analysis, Ion-solid interactions, Radiation damage, Diffusion
Dr A Ganswindt	Animal behaviour, Behavioural physiology, Animal reproduction, Behavioural endocrinology, Wildlife endocrinology, Reproductive endocrinology
Prof AM Garbers-Craig	Pyrometallurgy, Refractory materials
Prof RJ Green	Paediatric pulmonology
Prof S Gruner	Computer science, Software engineering, Software methodology, Formal Specifications of Systems * Model Driven Engineering * Theoretical and Methodological
Prof B Gummow	Veterinary epidemiology, Veterinary Preventive Medicine, Population Medicine

Prof JJ Hanekom	Speech processing, Electric hearing, Cochlear implants, Cochlear prosthesis, Biomedical engineering, Audiology
Prof T Hanekom	Computational modelling, Neuroscience, Cochlear implants, Neuroprosthetics, Auditory neuroscience, Physiological modelling, Finite element modelling
Prof SL Hendriks	Policy analysis, Agricultural growth, Development policy, Food security, Food policy
Prof PS Heyns	Diagnostics, Condition monitoring
Prof C Huyser	Sexually transmitted diseases, Affordable IVF, Assisted reproduction
Prof PC Irons	Infectious diseases, Reproduction
Prof NF Janse van Rensburg	Partial differential equations, Continuum mechanics
Prof JB Jansen van Ryssen	Animal nutrition, Animal production
Prof KH Jordaan	Special Functions, Orthogonal polynomials, Approximation theory
Dr FJ Jori	Wildlife medicine, Wildlife as food, Epidemiology, Disease ecology
Prof AM Joubert	Cell biology, Cell death pathways, Cell signaling, Cell Communication, Gene expression profiling - Cancer cells, Cell cycle regulation, Cell culture
Prof F Joubert	Bioinformatics
Prof EP Kearsley	Cementitious materials, Concrete materials, Construction materials
Prof A Kijko	Seismology, Risk assessment
Prof DG Kourie	Algorithms, Software engineering, Programming languages
Prof CJ Kruger	Information and knowledge management
Prof HW Kunert	Group theory, Solid state physics
Prof KJ Kunert	Plant biotechnology, Plant biochemistry
Prof N Lall	Ethnobotany, Pharmaceutical sciences, Ethnopharmacology, Natural products from plants, Phytomedicine
Dr C le Roux	Fluid mechanics, Partial differential equations
Prof AL Leisewitz	Feline/canine infectious diseases, Malaria, Animal modelling, Infectious diseases, Veterinary medicine, Immunology/companion animals
Prof LP Linde	Information theory, Numerical computation, Real-time computing, Simulation, Signal processing
Prof M-CN Madekurozwa	Histology, Veterinary anatomy
Dr I Mahmood	Thermal energy systems, Thermal sciences, Fluid thermal systems, Fluid dynamics, Advanced turbo machinery aerodynamics, Unmanned aerial vehicles, Gas turbines, Channel flows, Heat exchangers, Aerodynamics
Prof JAG Malherbe	Antennas and radiation, Electromagnetics, Microwaves
Prof NI Manyala	Experimental condensed matter physics
Prof W Markotter	Molecular virology, Animal virology, Veterinary virology, Zoonotic diseases
Dr MC Matthee	ICT skills, ICT and IS education, Technology enhanced education, Mobile learning, IS and education, Knowledge management and engineering, Enterprise architecture
Prof CME McCrindle	Veterinary epidemiology, Agricultural development, Veterinary public health
Dr LJ McGaw	Biological activity assays, Toxicity studies of medicinal plant extracts and isolated compounds
Prof D Meyer	Biomedical sciences
Prof A Minnaar	Food science and technology

Dr EW Mureithi	Fluid mechanics, Computational fluid dynamics, Mathematical modelling of infectious diseases, Numerical methods, Mathematical epidemiology
Prof JO Nothling	Animal reproduction
Dr PP Ntumba	Algebra, Differential geometry
Prof A Oelofse	Nutrition and health, Food-nutrition, Human nutrition, Children-nutrition, Community nutrition, Mineral nutrition, Nutrition and metabolism, Nutritional epidemiology, Micronutrient malnutrition
Prof MS Olivier	Information privacy, Digital forensics, Computer security, Information security
Dr JM Olwoch	Climate change - Impact, Climate change - Adaptation, Climate change - Vulnerability, Climate change mitigation, biological sciences
Prof MC Oosthuizen	Molecular parasitology, Veterinary parasitology, Molecular diagnostics, Molecular biology, Molecular parasitology, Wildlife - parasites, Parasitology
Dr J Pienaar	Genetic analysis and manipulation, Evolutionary biology, Evolutionary genetics
Prof E Pretorius	Scanning electron microscopy, Transmission electron microscopy, Coagulation
Prof L Pretorius	Technology Management, Dynamical systems, Energy management
Prof MW Pretorius	Technology management, Technological innovations
Dr LC Prinsloo	Infrared spectroscopy, Molecular spectroscopy, Raman spectroscopy, Optical spectroscopy
Prof JCdeW Rautenbach	Climate variability, Climate change, Meteorology
Dr CF Reinhardt	Weed science, Weed control, Plant production, Plant protection
Prof O Reva	Bioinformatics, Genomics, Industrial microbiology
Prof JL Roos	Human genetics, Schizophrenia, Neurogenetics, Genetic markers
Prof CZ Roux	Animal breeding, Animal production, Quantitative genetics, Population genetics
Prof RF Sandenbergh	Electrometallurgy
Prof N Sauer	Partial differential equations, Fluid dynamics, Evolution operators
Prof HC Schonfeldt	Food composition, Human nutrition, Food composition, Meat quality, Nutrient composition
Prof JT Soley	Veterinary anatomy
Prof MJ Somers	Conservation ecology, Wildlife ecology, Animal ecology
Prof ET Steenkamp	Molecular evolution, Molecular systematics, Evolutionary biology, Mycology
Prof V Steenkamp	Medicinal plants, Drug development, Cytotoxicity
Prof JM Steyn	Irrigation - Management, Crops - Water requirements, Crop modelling, Potatoes, Irrigation - Management, Crops - Water requirements
Prof PD Sumner	Geomorphology
Prof GE Swan	Clinical pharmacology, Veterinary pharmacology, Veterinary toxicology, Pharmacokinetics, Environmental health
Prof J Swart	Geometry of Banach spaces, Measure theory, Operator algebras
Prof MB Taylor	Viral gastroenteritis, Viral hepatitis, Antiviral testing, Food - Microbiology, Health related water microbiology, Molecular epidemiology
Prof CC Theron	Accelerator physics, Materials characterisation, thin film growth, ion beam analysis, Diamond research, Thin films, solid state interaction, Ion-solid interactions, Solid state reactions, Reaction kinetics
Prof J Theron	Orbiviruses, Viral gene silencing, Molecular virology

Prof NJ Theron	Vibration analysis, Vibration control, Signal analysis, Vehicle dynamics, Dynamics of structures
Prof RJ van Aarde	Conservation ecology, Restoration ecology, Community ecology
Prof JE van Den Berg	Algebra, Ring and Module Theory
Prof AJ van der Merwe	Business process engineering, E-learning, Process modelling, Ontology engineering, Enterprise architecture, Software engineering - software process (Models, methods, tools), Software engineering practice, Information systems
Prof SW van der Merwe	Infectious diseases
Prof WFP van Heerden	Forensic odontology, Oral biology, oral cancer, DNA ploidy, Oral manifestations of HIV/AIDS, salivary gland tumours, Pathology (Oral), Oral disease
Prof E van Marle-Koster	Animal breeding, Animal genetics, Animal production
Prof WA van Niekerk	Ruminant nutrition, Animal nutrition
Prof JL van Rooy	Engineering geology, Construction materials, Sinkholes, Hydrogeology, Soil mechanics
Prof MW van Rooyen	Population biology of plants, Seed science, Conservation biology, Ecophysiologist
Prof M van Vuuren	Antimicrobial resistance, Viral infections, Serology, Infectious diseases, Veterinary microbiology
Prof EH Venter	Veterinary virology
Prof HS Venter	Digital forensics, Wireless sensor networks, Network security, Intrusion detection, Information privacy
Prof M Venter	Medical virology, Arboviruses, Infectious diseases, Molecular epidemiology, Molecular virology, Molecular diagnostics
Prof SN Venter	Water quality management, Bacterial taxonomy
Dr S Verryn	X-ray diffraction, Mineralogy
Prof JA Verschoor	Biochemistry of mycolic acids in tuberculosis
Prof BHME Vinck	Otoacoustic emissions, Electrophysiology, Clinical vestibular research, Cochlear implants, Noise induced hearing loss
Prof EC Webb	Meat science, Animal production physiology
Dr CW Weldon	Applied entomology, Entomology, Physiological ecology, Behavioural ecology, Animal nutrition, Abiotic stress, Biotic stress
Prof VVS Yadavalli	Health systems research, Health sciences
Dr J Zhang	Energy modelling, Energy efficiency, Control systems, Energy management, Energy
Dr X Zhou	Plant health management, Plant sciences, Forest protection, Fungal taxonomy, Insect-fungal relationships, Fungal pathogens, Fungal population biology
CSIR	
Dr RD Anandjiwala	Textiles, Fibre reinforced composites, Natural fibre reinforced composites, Polymeric composites
Dr ERM Archer van Garderen	Climate change
Dr FS Roux	Quantum optics, Singular optics, Photonics/optics, Diffractive optics
Dr JL Nel	Conservation planning, Biodiversity conservation, Water resources management, Freshwater ecology, Sustainability science, GIS
Dr PJ Oberholster	Nano-ecotoxicology, Fresh water biology and limnology, Ecotoxicology, Aquatic resource management, Acid mine drainage, Ecology and environmental science, Eutrophication, Ecotoxicogenomics
Dr PW Loveday	Smart structures, Finite element methods, Waveguides, Ultrasound technology, Piezoelectric materials

| Prof ME Herselman | Information technology, Computer science, ICT4D projects, Community informatics, Mobile learning, Living Labs |
| Dr NZ Jovanovic | Soil water - Modelling, Crops - Water requirements, Geohydrology, Irrigation - Management, Soil salinity, Agricultural productivity, Hydrologic modelling |

Name	Research specialisations
Promising young researcher	
UP	
Dr DL Knobel	Veterinary medicine, Veterinary public health, Veterinary epidemiology, Demographic surveys, Infectious diseases, Veterinary microbiology, Veterinary virology, Veterinary science, Zoonoses, Zoonotic diseases
Dr N van den Berg	Plant pathology, Molecular plant microbe interaction
Dr M van der Laan	Nutrient management, Crop modelling
Dr K Landman	Affordable housing, Sustainable development, Sustainable development policy, Security studies, Housing - South Africa, Low cost housing, Human security, Housing development
Dr M Quan	Molecular virology, Veterinary epidemiology, Geographic information systems
Dr KP Sibeko	Molecular characterisation, Molecular diagnostics, Molecular parasitology, Molecular phylogeny, Molecular technology
Prof T Bello-Ochende	Convective heat transfer, Fluid Mechanics and Energy (renewable energy)
Prof L Birkholtz	Antimalarial drug discovery, Gene regulation, Malaria protein expression and biochemical characterisation, Structural biology, Antimalarial compounds, Malaria, Drug discovery, Functional genomics, Protein structure-function relationship, Gene expression and regulation
Dr M Chapwanya	Scientific computing, Industrial mathematics, Mathematical modelling
Dr C Chikozho	Water policy, Water resource governance, Integrated water resources management, water governance in rural livelihoods, climate change
Prof R Cockeran	Flow cytometric analysis, Antibiotic resistance mechanisms, Cellular immunology, Antibiotic screening, Infectious diseases, Mycobacterium tuberculosis, Applied immunology
Dr MPA Coetzee	Phylogenetics, Fungal taxonomy, Evolutionary biology, Molecular evolution, Evolutionary dynamics, Systematics (Biology), Phylogenetics, Fungal taxonomy, Evolutionary biology, Molecular evolution, Evolutionary dynamics
Dr BG Crampton	Fungal-plant interactions, Plant sciences, Plant biotechnology, Plant biotechnology: Grain crops
Dr J Wichmann	Air quality monitoring networks, Respiratory diseases, Survey methods, Survey data - Statistical analysis, Exposure assessment, Environmental epidemiology, Survival analysis
Dr JE van der Waals	Diagnostic plant pathology, Plant pathology
Dr JH van der Walt	Partial differential equations, Convergence, Set theoretic topology, Ordered algebraic structures, Ordered topological spaces
Dr JF Dalerum	Evolutionary ecology, Wildlife biology, Wildlife conservation, Carnivore biology, Wildlife ecology, Animal ecology, Terrestrial ecology
Prof MP Robertson	Biogeography, Invasive alien species, Biodiversity conservation, Spatial modelling
Dr WP du Plessis	Radar, Electronic warfare
Dr J Dirker	Heat transfer - Conduction, Electronics cooling, Heat transfer - convection

Prof TB Dzikiti	Veterinary pain management, Veterinary anaesthesia
Dr A Hassen	Pasture science, Pastures, Animal nutrition
Dr MK Oosthuizen	Neurobiology, Basic endocrinology and physiology
Dr MN Emmambux	Starch, Food nanotechnology, Food rheology
Dr CCW Pirk	Entomology, Applied entomology, Behavioural Ecology, Chemical Ecology
Dr WE Meyer	Defects in semiconductors, Electrical characterization of semiconductors
Prof V Naidoo	Drugs - Toxicology, Veterinary pharmacology, Wildlife conservation
Dr HM Oberholzer	Ultrastructure
Dr C Maritz-Olivier	Animal health, Veterinary parasitology, Recombinant protein production, Vaccine development, Phylogeography, Phylogenetics, Microarray technology, Biotechnology proteomics and molecular biology
Prof JW Joubert	Mathematical optimisation, Algorithms for optimisation, Combinatorial optimisation, Simulation
CSIR	
Dr MJ John	Polymers, Natural fibres and composites
Dr PJ O'Farrell	Ecosystem services
Dr S Kok	Finite element analysis, Computational plasticity, Numerical optimisation
Dr S Das	Mathematical statistics, Applied statistics, Bayesian statistics, Extreme value theory (Statistics), Structural equation modelling, Employee health, Spatial modelling, Medical statistics, Statistical modelling, Economic statistics
Dr WJ de Lange	Behavioural economics, Environmental pollution, Environmental decision making, Ecological economics, Water resources management, Environmental and resource economics, Sustainability science, Sustainable development policy, Agricultural economics, Consumer behaviour
Dr LE Dziba	Plant herbivore interactions, Ecology and management of rangelands, Nutritional ecology of grazing animals
Dr FA Engelbrecht	Numerical modelling, Climate change
Prof MM Grobler	Cyber security awareness, Digital forensics, Information security governance, IT law
Dr SA Archibald	Savanna ecology, Fire ecology, Fire-grazer interactions, Vegetation dynamics, Global change research
Dr CY Wright	Exposure assessment, Public health

Name	Research specialisations
NRF prestigious awardee	
UP	
Prof DCD Swanepoel	HIV and AIDS - Hearing, Deafness - Early intervention, Hearing disorders - Diagnosis, Telemedicine, Occupational health, Hearing impaired children, Deafness - Identification
Prof B Slippers	Evolutionary ecology, Molecular ecology, Chemical ecology, Ecology of parasites, Biological control systems, Symbiosis, Insect-fungal relationships

LIST OF ABBREVIATIONS

ACGT	- African Centre for Gene Technologies
AFTER	- African Food Tradition REvisited by Research
ASNSA	- Advanced Sensor Network South Africa
ARC	- Agricultural Research Council
ASN	- Advanced Sensor Network
ATR-FTIR	- Attentuated Total Reflectance Fourier Transform Infrared
BALSS	- Bio-artificial Liver Support System
BOD	- Biological Oxygen Demand
CSIR	- Council for Scientific and Industrial Research
DO	- Dissolved Oxygen
DST	- Department of Science and Technology
EDRC	- Electronic Defence Research Centre
EU	- European Union
EU-ACP	- European Union Africa, Carribean and Pacific
EW	- Electronic Warfare
FBG	- Fluidised Bed Gasifier
GCP	- Generation Challenge Programme
HART	- Highway Addressable Remote Transducer
KACST	- King Abdulaziz City of Science and Technology
ICT	- Information and communication technology
IGCC	- Integrated Gasification Combined Cycle
IRTPS	- Intelligent Real-Time Power Systems
NBN	- National Bioinformatics Network
NRF	- National Research Foundation
R&D	- Research and Development
RDI	- Research, Development and Innovation
SABINA	- Southern African Biochemistry and Informatics for Natural Products
SAMI	- South Africa Malaria Initiative
SEM	- Scanning Electron Microscopy
SERA	- Southern Education and Research Alliance
SINTEF	- Selskapet for Industriell og Teknisk Forskning
SMME	- Small, Medium and Micro-sized Enterprises
THRIP	- Technology and Human Resources for Industry Programme
TIA	- Technology Innovation Agency
TME	- Time, Measurement and Evaluation
TUT	- Tshwane University of Technology
UCT	- University of Cape Town
UJ	- University of Johannesburg
UKZN	- University of KwaZulu-Natal
UP	- University of Pretoria
VRE	- Virtual Research Environment
WITS	- University of the Witwatersrand

ACKNOWLEDGEMENTS

Definitions of NRF researcher ratings

- **Leading international researcher** – researchers who are unequivocally recognised by their peers as leading international scholars in their field for the high quality and impact of their recent research outputs

- **Internationally acclaimed researcher** – researchers who enjoy considerable international recognition by their peers for the high quality and impact of their recent research outputs

- **Established researcher** – established researchers with a sustained recent record of productivity in the field who are recognised by their peers as having:
    - Produced a body of quality work, the core of which has coherence and attests to ongoing engagement with the field,
    - Demonstrated the ability to conceptualise problems and apply research methods to investigate them.

- **Promising young researcher** – Young researchers (age 40 or younger), who have held the doctorate or equivalent qualification for less than 5 years at the time of application, and who are recognised as having the potential to establish themselves as researchers within a five year period after evaluation, based on their performance and productivity as researchers during their doctoral studies and/ or early post-doctoral careers.

- **Prestigious awardee** - Young researchers (younger than 35 years of age), who have held the doctorate or equivalent qualification for less than five years at the time of application and who, on the basis of exceptional potential demonstrated in their published doctoral work and/or their research outputs in their early post-doctoral careers are considered likely to become future international leaders in their field.