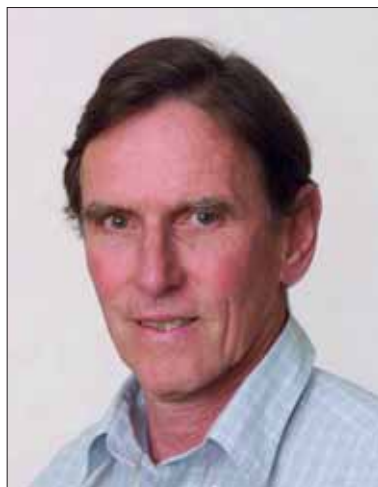


# NSTF-BHP Billiton Awards



Advertising supplement to the **Mail & Guardian** June 28 to July 04 2013

## Awarding research excellence and beyond



Prof Robert Millar



Prof Marietjie Venter



Prof Graeme Cumming



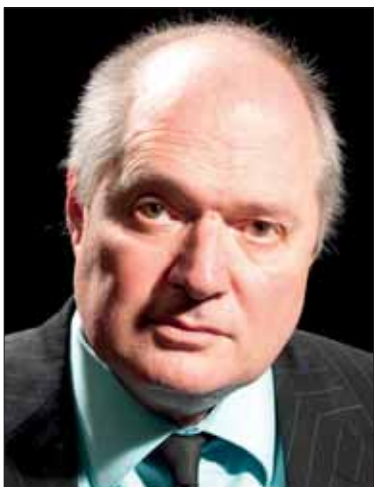
Prof Saurabh Sinha



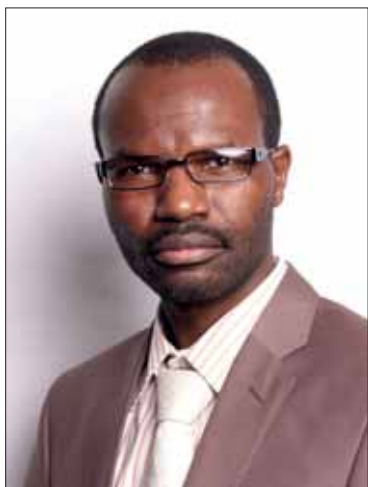
Dr Bernard Fanaroff



Dr Marieka Gryzenhout



Prof David Block



Dr Robert Tshikhudo



Dr Philip Loveday



Dr Keith Fergusson

Science, engineering and technology (SET) are important economic drivers within South Africa, and advance the competitive nature of the country globally. These are areas that should be celebrated and acknowledged. The National Science and Technology Forum (NSTF) Awards, in partnership with BHP Billiton, does just that.

The awards ceremony was held on June 27 2013 in Johannesburg, with the national awards addressing areas beyond research excellence.

"There is immense potential for research to impact on society and improve people's lives. People need to be aware of the findings of research and the implications for their lives, and decision makers should be aware of the findings that have implications for government policy at all levels."

Niehaus adds that translating research into marketable innovation is also an emphasis within the awards and that the judging criteria consider the potential to commercialise research.

Another important aspect is the

development of young researchers and the role that winners play in inspiring students to move into the SET field. SET communication and outreach becomes essential, not only for the youth, but to inform the larger public.

"Science cannot happen behind closed doors. It is part of a value chain that ultimately needs to have societal impact on multiple levels," says Niehaus.

The NSTF-BHP Billiton Awards are open and anyone, including the

To Page 2



Prof Lesley Cornish



Dr Attie Jonker

### Support science outreach with the NSTF-BHP Billiton Award winners



On 27 June 2013, the National Science and Technology Forum (NSTF) announced the winners of the 15<sup>th</sup> NSTF-BHP Billiton Awards recognising excellence in Research in various fields. Winners will now embark on a national publicity campaign, acting as science ambassadors through the *Share 'n Dare* science outreach programme, and will be presenting radio interviews, public lectures and motivational talks to learners and students. There are no better role models than these top scientists, engineers, technologists, entrepreneurs, and science communicators!

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NSTF-BHP Billiton Awards

Awarding research excellence and beyond

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public, can make a no mination. The adjudication panel is inclusive of various sectors of the scientific community.

“The awards are also not owned by a single entity. Particular award categories are sponsored by the National Research Foundation (NRF), Eskom, the South African Agency for Science and Technology Advancements (Saasta) and the Technology and Human Resources for Industry Programme (Thrip) of the department of trade and industry (Dti),” says Niehaus.

The event and publicity are predominantly sponsored by BHP Billiton, the NRF, Saasta, The departent of science and technology (DST), Eskom, Thrip, the Dti, the Council for Scientific and Industrial Research (CSIR), the *Mail & Guardian* and Business Report.

“A unique intervention of the Awards is the science outreach and publicity campaign,” says Niehaus. “Award winners act as science ambassadors through the NSTF Share ’n Dare science outreach programme and will be doing radio interviews, public lectures and motivational talks to learners and students across the country. There are no better role models than these top scientists, engineers, technologists, entrepreneurs and science communicators.”

The initiative has proven valuable in motivating the youth to pursue studies and careers in the sciences and engineering.

During the past year, award winners participated in podcasts streamed on the NSTF Awards website. They were also involved in a broad range of activities such as radio interviews, science talks to high school learners and special lectures at universities.

“YouTube videos of these events have attracted multiple hits,” says Niehaus. She says that the programme is open and organisations that want to participate should contact the NSTF.

Below are the 2013 NSTF-BHP Billiton award winners:

**Lifetime achievement award:** Professor Robert Millar, an A-rated scientist, is a leading international neuroendocrinologist. He has discovered new hormones and receptors, developed analogue drugs and has taken various reproductive treatment drugs to the human stage.

His development of hypothalamic hormone analogues (a synthesised form of the hormone) has resulted in the treatment of a number of diseases, ranging from prostatic cancer to endometriosis.

Millar co-ordinated trials for Triptorelin, the first and only time all clinical trials and development

have taken place in South Africa. He also established the first peptide synthesis facility in the country.

Millar founded a UK-based biotech company, took 10 novel molecules into man and has over 20 patents.

**TW Kambule NRF-sponsored outstanding senior researcher awards:** Professor Marietjie Venter has, over the past 10 years, defined the role of several viruses as causes of pneumonia as well as neurological disease in humans and animals. This is significant as pneumonia and meningitis are two of the major causes of death worldwide.

She established the first Respiratory Syncytial Virus (RSV) laboratory in South Africa and published the first work on RSV molecular epidemiology in South Africa. She and her team defined RSV as the most important pathogen for pneumonia in babies.

Venter’s work established West Nile Virus (WNV), and several other unknown neurological viruses, as the cause of death in horses and wildlife across Africa. It also showed that WNV is missed as a cause of meningitis and other neurological diseases in South African hospitals.

Professor Graeme Cumming researches the theory and application of complexity theory in ecological and social-ecological systems. Complexity theory, in essence, considers the way a set of complex processes come together to produce patterns.

Among other significant outputs, his contributions have included the development of new theoretical frameworks for analysing linked systems of people and nature, in-depth analyses of specific conservation problems, and the development of new approaches to modelling and quantifying broad-scale pattern-process interactions.

Cumming’s unique contribution to the development of both complexity theory and landscape ecology has been to combine ideas and methods from different disciplines in the context of the analysis of spatial pattern-process relationships and the resulting dynamics.

**TW Kambule NRF-sponsored distinguished young researchers awards:** Professor Saurabh Sinha’s research and outputs consider the mechanisms to increase bandwidth, specifically through millimetre waves (mm-waves). This has become critical for countries globally as the amount of data transferred wirelessly is getting bigger while radio spectrum becomes scarcer.

The mm-wave refers to extremely high frequencies, such as the 57-64 GHz and the 86 GHz range. The focus is on faster data rates but using lower power.

Sinha initiated the mm-wave integrated circuit research focus for the faculty of engineering, built environment and information technology, University of Pretoria. The unique approach followed by Sinha and his research team makes use of a cost-competitive silicon-based technology (SiGe).

Dr Marieka Gryzenhout used systematics to study the pathological significance, mycogeography (location) and movement, biodiversity and ecological significance of fungi in plants. She has published a monograph on Cryphonectriaceae, a family of the most destructive tree pathogens in the world.

The detailed work looks at the fungi’s ecological role and pathological significance. It provides a synopsis of previous literature on the fungi family, plus how to identify this type of fungus through morphology, diagrams, identification keys and a list of DNA sequences. There is also a detailed description and some background on each species in the family.

The major outcome of Gryzenhout’s work is a comprehensive revision of the names of these fungi, the creation of an identification system for them, and the description of a new and comprehensive family to include these pathogens. The work has become essential in the research and control strategies of these pathogens.

**Management and related SETI activities (other than R&D) award:**

The SKA SA Project Team has been instrumental in winning the bid to host the Square Kilometre Array (SKA), an extremely advanced and powerful radio telescope. Although it is a dual-site implementation model between Africa and Australia, more than 70% will be built inside South Africa’s borders. There are also partnerships with eight African countries regarding hosting remote stations.

The team started working on the bid in 2002 and developed a robust SKA hosting plan. It has been managing the phases since then. SKA is a global project, with national and global stakeholders.

SKA will generate research, attract youth into the science, engineering and technology (SET) field and promote South Africa as a primary scientific destination. It will push the boundaries of technology and provide answers to fundamental questions in physics, astronomy and cosmology.

**Saasta-sponsored Science Communication for Outreach and creating Awareness award:**

Professor David Block, from the school of computational and applied mathematics and the director of the cosmic dust laboratory at the University of the Witwatersrand,

has an extensive research record in astronomy. He has been called a “public intellectual” for his ability to communicate science to a wide range of audiences.

His public outreach has been vast, starting in 1976 and it includes national and international radio and television interviews. Block has organised numerous outreach programmes for schoolchildren and their teachers over the last 10 years, presented numerous public astronomy lectures and invited distinguished international scholars to present to the public.

Block has organised four international astronomy conferences and is the only scientist in Africa to have his research appear twice on the cover of “Nature”, an international science journal.

**Eskom-sponsored Research capacity development awards:**

Professor Lesley Cornish is the prime instigator and is now the director of African Materials Science and Engineering Network (Amsen) which includes five participating universities from South Africa, Namibia, Kenya, Nigeria and Botswana. Amsen’s intention is to develop the next academic generation through collaborative research. There are currently 20 Amsen students. Each student has at least two supervisors across the network, and this allows for better supervision, improved access to equipment, as well as the mentoring of less experienced staff during the co-supervision.

Dr Robert Tshikudo is director and head of the Mintek Nanotechnology Innovation Centre (NIC). Through the NIC and along with chairman, Dr Makhapa Makhafola, he has been developing research platforms, promoting collaborative networks, addressing human capacity, establishing world-class infrastructure, and developing innovative nanotechnology-based systems and devices for health (diagnostics and therapeutics) and water treatment applications. Some of the nanomaterials and diagnostic prototype devices have reached the industrialisation and commercialisation stages.

The Mintek NIC is a multi-user facility spread across South Africa comprising three science councils and various universities. Human capacity development outputs include developing the existing expertise at universities, training and the production of postgraduate students.

**Research for innovation awards:**

The Adaptive Real-Time Internet Streaming Technology (Artist) Project was a collaboration between the CSIR, University of Cape Town and East Coast Access. It led to the development of a new technology platform that

enables viewers to watch live content on mobile devices from anywhere in the world, with minimal interruption to their video stream.

The patented technology has resulted in a new Pan African mobile Internet Protocol Television industry. The low-bandwidth video broadcast platform has been licensed to a start-up called Tuluntulu, that intends to become the number one mobile video content gateway in low bandwidth or congested environments.

The Ultrasonic Broken Rail Detection Team, from the Institute for Maritime Technology and CSIR, developed a world-first solution that detects breaks on Transnet’s heavy freight railway lines. It’s a tailored solution that prevents costly derailments of trains. The Ultrasonic Broken Rail Detection system is able to detect rail breaks remotely and in real-time by sending and receiving high frequency sound along the rails. Operators are now able to receive real-time alerts enabling immediate action that saves lives, structural damage, and money. The positive impact of this solution surpasses conventional manually-intensive inspection techniques. With great export potential, the system is currently undergoing tests on foreign rail networks.

JS1 Development Team, from SMME Jonker Sailplanes, developed the JS1C sailplane as a competitive Open Class Sailplane for the 2012 World Gliding Championships, USA. The wing of the JS1 was redesigned and extended to 21m to increase performance. Four of these gliders ended up in the top 10, one finishing third overall. A key success factor of the project was the collaboration with North-West University.

**Building future scientists**

Developing the youth, run by the NSTF in collaboration with BHP Billiton, the Department of Basic Education and provincial departments of education, the NSTF Brilliants programme recognises 18 top maths and science performers in national public schools. These students come from the previous year’s grade 12.

The intention is to show what science, engineering and technology can offer them. There is a pre-ceremony with the Deputy Minister of Basic Education and the BHP Billiton board chairperson, and the students attend and are acknowledged at the overall awards. Personal and professional development mentoring is also provided through a speakers’ programme.

The Thrip bursary programme is for undergraduate students in engineering and the sciences, with recipients announced and recognised at the NSTF-BHP Billiton Awards. This year two of the Brilliants programme top performers received bursaries.



## Lifetime achievement

## A life dedicated to science

Debbi Schultz

**N**euroendocrinology is the study of the interactions between the nervous system and the endocrine system. For those to whom school biology is a distant memory, neuroendocrinology is the way in which factors from the external and internal environment (such as stress and nutrition) are integrated in the brain to regulate hormones, which then influence bodily functions (such as growth and reproduction).

And so explains Professor Robert Millar. A leading international figure with an extensive body of work, Millar discovered new hormones and receptors, developed analogue drugs and has taken them into the clinic.

These hormones originate in the hypothalamus, at the base of the brain. They target the pituitary gland, which then produces other hormones that regulate most of the body's functions, such as metabolism, appetite, inflammation, stress and reproduction.

The first three hypothalamic hormones were discovered by Schally and Guillemin and led to a Nobel Prize for their work. In 1982, Millar and his student, Judy King, discovered the structure of a new hypothalamic hormone which regulates reproduction.

The professor's work has contributed to the development of analogues of hypothalamic hormones for the treatment of a number of diseases, ranging from prostatic cancer to endometriosis. (An analogue is a synthesised form of the hormone.)

In many instances, the treatment has been revolutionary. Triptorelin, an analogue drug for treating prostatic cancer, is a case in point.

"Previous treatments for prostatic cancer weren't very successful," says Millar. "Now the main treatment is with an analogue of the gonadotropin-releasing hormone, such as Triptorelin, and it has much better results."

Triptorelin was not only a success in terms of treatment, but also drug registration. The pharmaceutical company that had bought the rights needed to register the drug with the US Federal Drug Agency. "FDA registration is a very difficult process on all levels, including cost. I moti-

vated that all clinical studies were conducted in SA," explains Millar.

The decision to do so saved the company around \$50-million.

Triptorelin is the first and only drug for which all clinical trials and development took place in South Africa.

In the course of his work, Millar established the first peptide synthesis facility within South Africa in 1985. (All natural hormones are peptides, a smaller version of a protein.) The facility allowed for the design, synthesis and patenting of a wide range of hypothalamic hormones. These analogue drugs were then used extensively for both diagnosis and treatment.

Millar supplied these drugs to hospitals throughout South Africa, free of charge. At the time, the drugs were mostly not available and others were too expensive.

Starting with an interest in how hormones convey information to cells, Millar's work includes the discovery of cognate receptors and the intracellular signalling induced by the binding of these hormones to their receptors.

"This is where the hormone binds to a specific type of receptor in the cell and causes signalling inside the cell's pathways," he explains.

In 2000, Millar founded a UK-based biotech company, Ardana, where the main focus was on reproductive health conditions. The company raised £73-million in venture capital, was listed on the London Stock Exchange, took three drugs into the market and three others into phase two.

It also received a number of awards and launched various research programmes.

Millar's ability to bring his work to market is unusual. "Most researchers don't know how to commercialise their discoveries. There is a belief that it's easy to make this translation," says Millar, who was chief scientific officer at Ardana.

His message to those wishing to bridge the divide? From the outset, make it a practical solution.

Millar has taken 10 novel molecules into man (to the human stage). There are few people that have managed this accomplishment, including life-time employees within the pharmaceutical industry. Getting to the stage of being able to treat humans is very difficult, on every level, and one drug alone costs at least \$1-billion to get to this point.

While not all of the molecules were translated into mainstream drugs, Triptorelin and Elagolex (developed by Neurocrine for endometriosis) did reach this stage. Millar contributed to these and other analogues that reached successful translation.

Millar has over 20 patents, ranging from potential treatments for cancers to novel contraceptives. He has also developed a novel hormone used to stimulate spawning in fish for aquaculture.

Born in South Africa, Professor Millar grew up in Zimbabwe where he did his undergraduate degree in chemistry, zoology and botany. He then studied in the UK, obtaining his master's in biochemistry and PhD in reproductive biology.

He also obtained his MRCPath and FRCPath at the Royal College of Pathologists in London. This was after moving to the University of Cape Town (UCT), where he became a full professor in 1984 and headed up the Medical Research Council's Peptide Biology Unit for many years. He was then recruited as the director of the Medical Research Council's Human Reproductive Sciences Unit in Edinburgh in 1998.

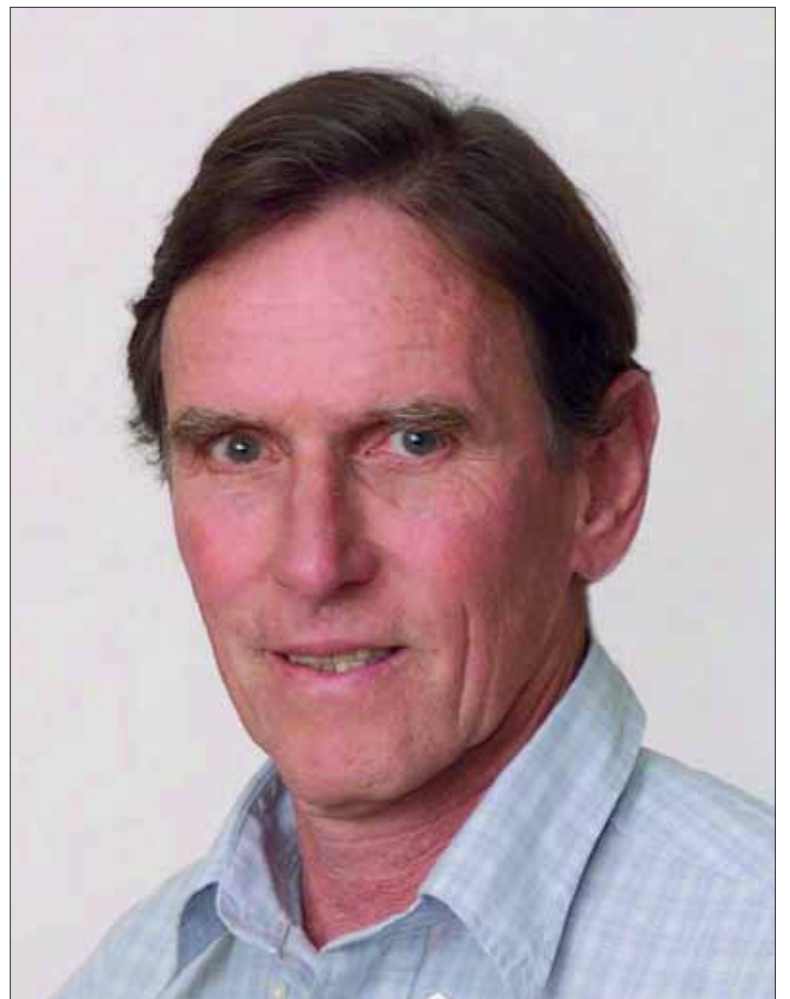
In a new direction and requiring different expertise, in 2011 he was appointed as the director of the Mammal Research Institute, University of Pretoria, focusing on African mammal conservation. While it's unusual for a researcher to take up a completely new direction, Millar has always had an interest in wildlife conservation.

He hasn't left biomedicines behind. Currently, he is also the co-director of the UCT/MRC Receptor Biology Group.

Millar is now working on other peptides that regulate body functions. About three years ago, he discovered "chaperone" molecules that can engage mutated human receptors (that fail to function because they do not traffic to the cell surface) and take them to the cell surface (where they should be located).

This has major significance in the treatment of many diseases. An example is retinitis pigmentosa, which results in blindness. This is due to a failure of the light-detecting receptor in the eye to reach the cell surface. "If you can bring the light receptor to the surface, it will prevent people with this disease from going blind."

Millar is an NRF A-rated scientist



Prof Robert Millar

and has been published in over 400 internationally peer-reviewed journals. His work has been cited more than 10 000 times. Millar has also supervised over 40 postgraduate students.

Among other awards, Millar has received the Wellcome gold medal, the Oppenheimer gold medal, the Geoffrey Harris laureate and the Ernst and Berta Scharrer laureate

of international societies. He is also a Fellow of the Royal Society Edinburgh and a Fellow of the Royal Society South Africa.

**Professor Robert Millar is the winner of the NSTF-BHP Billiton lifetime achievement award: to an individual for an outstanding contribution to SETI over a lifetime**

It is a remarkable feat to be awarded the NSTF-BHP Billiton Lifetime Award. This is special recognition of an outstanding contribution to science, engineering and technology (SET) within South Africa, over a lifetime.

The 2011/2012 Lifetime Award winner was David Glasser, a professor of chemical engineering and the founder and director at the Centre of Material and Process Synthesis (Comps), University of the Witwatersrand. He is internationally recognised for groundbreaking research in design and

reactor theory, as well as synthesis processes that produce energy from waste. He and his team have made a major contribution to the way chemical plants are designed.

In 2010/2011, Professor Lionel Opie, one of South Africa's foremost cardiology physician-scientists, won the Lifetime Award. His lifelong work has led to a better understanding of the causes of heart attacks and the improved use of heart medications. He is Director Emeritus of the Hatter Cardiovascular Research Institute at the University of Cape Town.

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TW Kambule Awards

# Eradicating the strains of disease

Debbi Schultz

Professor Marietjie Venter's early fascination with molecular biology, genetic engineering and virology has benefitted South Africa and the health industry in particular.

Over the past 10 years, she has defined the role of several viruses as causes of pneumonia as well as neurological diseases in humans and animals. This is especially significant because pneumonia and meningitis are major causes of death worldwide.

In 1999, Venter established the first respiratory syncytial virus (RSV) laboratory in South Africa at the National Institute for Communicable Diseases (NICD).

There was little information on viral causes of severe respiratory diseases in Africa prior to 2001.

Venter, who has a PhD in medical virology, published the first work on RSV molecular epidemiology in South Africa and, over 10 years, showed how strains are replaced annually with new ones.

The work explained why outbreaks occur each year and identified several new genotypes that may cause mild and severe disease in children. Along with her team, she identified RSV as the most important pathogen for pneumonia in babies.

"Respiratory viruses vary yearly, developing new species called genotypes. Molecular epidemiology investigates the genetic makeup (genome) of the pathogen to explain how it changes over time or how new strains emerge to cause outbreaks," explains Venter.

In 2002, she was appointed to the Special Pathogens Unit where she was involved in research and diagnoses of outbreaks of highly pathogenic vector-borne zoonotic viruses from across Africa. "Zoonotic" means they are transmitted from animals to humans and the "vector" can be insects or animals.

This move occurred shortly after West Nile Virus (WNV) emerged as a new cause of neurological disease in the US and the virus became one of her main focuses for the next 10 years.

WNV is an arbovirus (transmitted by insects, in this case mosquitoes) and is endemic to South Africa, but few cases are reported.

She established the respiratory and zoonotic virus research group at the University of Pretoria (UP) in 2005 and set out to define the major causes of pneumonia in children as well as zoonotic causes of meningitis.

She continued her work on RSV and defining the role of several newly described respiratory viruses in pneumonia in South Africa. At the same time, she also set out to define

the pathogenesis and role of WNV in human and animal disease. She was able to prove that South African WNV strains were just as pathogenic as those in the US.

Through veterinarians, Venter established a surveillance network in sentinel horses across the country. (Horses are especially sensitive to WNV).

"The network helps notify us when the disease emerges, particularly neurological cases. It has shown that WNV is widespread and occurs regularly, but is missed because it is not tested for," says Venter.

Her work established WNV as well as several other unknown neurological viruses as the cause of death in horses and wildlife across Africa. It also showed that WNV is missed as a cause of meningitis and other neurological diseases in South African hospitals.

In 2009 Venter became the head of the centre for respiratory diseases and meningitis' virology section at the NICD. It is the World Health Organisation's National Influenza Centre (NIC) and regional reference lab for influenza surveillance and research in Southern Africa. Venter is also director of the NIC.

While the NICD has had a viral watch programme since 1984, an intensive Severe Acute Respiratory Infection (SARI) surveillance



Prof Marietjie Venter

programme was established in 2009 shortly before her appointment.

"The programme facilitates influenza and other respiratory virus surveillance in mild as well as severe cases in South Africa. This enables us to contribute to the selection of the influenza vaccine strain for the southern hemisphere. It also informs South Africa's policy on influenza pandemic preparedness and surveillance," says Venter.

Her team led the diagnosis and molecular epidemiology investigation of the Influenza A H1N1 pandemic in South Africa during 2009. Venter defined the molecular epidemiology, using the genetic material of the virus to see how the strain differed from those in the rest of the world and how it was introduced into South Africa.

"We were able to show that it is the

same strain and will protect us when used in the vaccine for the southern hemisphere," she says.

Venter currently has a joint appointment between the NICD centre for respiratory disease and meningitis and the UP department of medical virology, heading up the zoonosis research unit. Through these positions, she continues her work on viruses in pneumonia and zoonotic viruses causing neurological infections in humans and animals.

**Professor Marietjie Venter is the winner of the TW Kambule Award, sponsored by the NRF: To an individual for an outstanding contribution to SETI through research and its outputs over the last five to 10 years**

# Understanding the complexity in conservation

Debbi Schultz

Professor Graeme Cumming, Pola Pasvolsky chair in conservation biology at the University of Cape Town, researches the theory and application of complexity theory in ecological and social-ecological systems.

So what exactly is complexity theory? "Let's start with a person viewed as a complex system," explains Cumming. "There is seldom one thing that governs day-to-day behaviour unless it's an overwhelming motivation where it's easy to connect cause and effect. However, you can pick up patterns and try to understand them."

He says that complexity theory considers the way a set of complex processes comes together to produce patterns. This is applied to various areas; in Cumming's case it's ecological and social-ecological systems. While there is the biology to consider, conservation also includes people, their role and impact.

Complexity theory cuts across all disciplines — from sociology and chaos theory to economics and fuzzy logic — but has its roots in computational mathematical science. It is a set of concepts that attempts to explain complex phenomena not easily done so by traditional theories.

Cumming's social-ecological focus is particularly in relation to spatial variation, connectivity and context regarding the conserva-

tion and management of natural resources.

"Spatial variation, in the social-ecological context, considers patterns of human interaction in relation to changes in the environment. For example, there is a difference in the interaction in cities compared to that in nature," says Cumming.

Among other significant outputs, his contributions include the development of new theoretical frameworks for analysing linked systems of people and nature, in-depth analyses of specific conservation problems, and the development of new approaches to modelling and quantifying broad-scale pattern-process interactions.

While Cumming's work is built around complexity theory, it also draws on resilience analyses and his prior research on landscape ecology. Analyses of resilience look at the ability of a system to cope with external "shock" and to keep its identity, as well as the ability to maintain that identity over time.

Landscape ecology deals with the relationships between patterns in ecosystems at broad spatial scales (such as the distribution of forests) and the processes (such as agriculture) that influence them.

Cumming's unique contribution to the development of both complexity theory and landscape ecology has been to combine ideas and methods from different disciplines in the

context of the analysis of spatial pattern-process relationships and the resulting dynamics.

For instance, in one of his most highly cited papers, he was able to take the concepts of hierarchy theory (from complexity theory) and patch dynamics (in landscape ecology) and apply them to understanding and describing the scale mismatches that can occur between management approaches, power, and the rates and magnitudes of change in ecosystems.

Cumming illustrates this by example: "If managers in the Kruger Park want to maintain water quality and quantity in the Letaba River, they must ensure that the upper reaches of the river, which fall outside the park boundary, are not polluted or planted with exotic tree species that use excessive amounts of water."

"The managers of the Kruger don't have the power to regulate upstream activities. This is an example of a scale mismatch, in which the scale of the problem is larger than the scale at which conservation management can act."

"Resolving the scale mismatch requires the development of mechanisms that operate at broader scales, such as regional legislation and cooperation, to achieve a necessary outcome. In practice, it means working closely with the human community that lives upstream. Since the interaction includes both social and ecological elements, it functions as a coupled social-ecolog-



Pola Pasvolsky chair in conservation biology at the University of Cape Town, Prof Graeme Cumming

ical system."

Cumming has collaborated in numerous areas including the Millennium Ecosystem Assessment's global scenarios group where his ideas and work around environmental decision-making were widely circulated to the international policy and management community.

He has made several methodological advances in the area of spatial

analysis and has successfully applied state-of-the-art statistical techniques in ecological contexts. His ideas about identity and resilience have been widely adopted in resilience analysis.

His 2011 book on spatial resilience is also the first major publication in this new interdisciplinary research field.

But it isn't all about research. His recent work on avian influenza has led to intervention strategies. His ongoing research on protected areas is contributing to the sustainable development of the tourism and game industries while also improving understanding of conservation issues and fostering stronger links between stakeholders.

Cumming has published widely, given numerous talks including several international keynote addresses and has supervised 31 postgraduate students.

His research has both local and international importance, making substantial contributions to conservation and management strategies for areas and resources that matter to people.

**Professor Graeme Cumming is the winner of the TW Kambule Award, sponsored by the NRF: To an individual for an outstanding contribution to SETI through research and its outputs over the last five to 10 years**

## TW Kambule Award

# Fungal 'CSI work' becomes a classification journey

This microbiologist  
is also a detective  
and historian

Iwan Pienaar

**T**he categorisation of fungi is a phrase that holds a world of cutting-edge science and historical detective work. This is the world of Dr Marieka Gryzenhout.

Gryzenhout, a senior lecturer at the University of the Free State, has a PhD in microbiology and is best known for her contributions to fungal systematics.

Systematic studies are where biological entities are described, re-classified and their relationships to related species defined. It is broader than traditional taxonomy which classifies predominantly through morphology.

She has used systematics to study the pathological significance, mycogeography (location) and movement, biodiversity, and ecological significance of fungi in plants.

"In part, my work is about being a plant doctor who identifies diseases and works out how to control or prevent them.

"Plant pathology also incorporates traditional pathology where you need to find out why the plant is dead," says Gryzenhout. "It's just like 'Plant CSI' but without the blood."

Gryzenhout focuses on mycology, the study of fungi.

She says that every plant has fungi on it, although it is often microscopic, and some of the fungi makes the plant ill.

In 2006, she published a mono-

graph on a family of tree pathogens called Cryphonectriaceae. This is an important fungus that occurs globally and includes some of the most destructive tree pathogens in the world.

The detailed monograph looks at the ecological role of Cryphonectriaceae and their pathological significance. It provides a synopsis of previous literature on this fungal family, as well as how to identify the fungus through morphology, diagrammes, identification keys and a list of DNA sequences.

The work has its roots in Gryzenhout's PhD studies when a collection of isolates (cultures) representing this family became available from an international collaborator.

Her supervisor also went on global field trips, bringing back numerous other specimens.

"The collections had not yet been characterised based on DNA sequence comparisons and appropriate phylogenetic analyses," says Gryzenhout.

Phylogenetic analyses involve statistical tools to look at the relationships between fungi based on DNA sequencing.

The aim of the project and following research was to revise the taxonomy of this important group of global pathogens to facilitate more accurate and rapid species identification.

"After checking against old taxonomy, it was clear that almost everything about the systematics needed to be changed," says Gryzenhout.

"This is where I needed to become a detective and a historian."

She had to find numerous docu-

ments and often from a long time ago (the first species in the group was described in 1823). It involved making contact with libraries all over the world.

Translation of the material often proved to be cryptic, resulting in a number of naming options.

"I had to look for name changes and then make decisions on which name to use. There was also the question of whether it's actually a new species needing a new name," says Gryzenhout.

The major outcome of her work was a comprehensive revision of the names of these fungi, the creation of an identification system for them, and the description of a new and comprehensive family to include these pathogens.

The work is ongoing as more of these fungi are being discovered.

The monograph and research are aimed at diverse scientists working with these fungi, as well as

foresters, pathologists and quarantine officers who have to deal with the problems caused by them.

The relationships of these fungi, based on DNA sequence similarities and differences, were re-assessed for the first time.

"I realised that Cryphonectriaceae is a new family in the order. This has opened the way for the possibility of other fungi to be new families, even though they may be morphologically diverse," says Gryzenhout.

The new system of classification and identification serves as the foundation for future work by mycologists. However, for a number of years Gryzenhout was the only expert on the new taxonomic classification of these fungi.

Overall, the work has become essential in the research of and control strategies for these pathogens.

Gryzenhout has published internationally and supervised 22 post-

graduate students.


She is the regional Africa representative for the International Mycological Association, president of the African Mycological Association and secretary of the International Society for Fungal Conservation.

She is a member of the South African Young Academy of Science, won the Ethel Mary Doidge Medal for the Best Young Mycologist from Africa in 2011 and the International Union of Forestry Research Organisations' Outstanding Doctoral Research Award in 2010.

**Dr Marieka Gryzenhout is the winner of the TW Kambule Award: To an emerging researcher for an outstanding contribution to SETI through research and its outputs over a period of up to six years after award of a PhD or equivalent in research, sponsored by the NRF**




Dr Marieka Gryzenhout



Congratulations to all NSTF BHP Billiton Awards Finalists.

**A Special Congratulations to the five finalists from the SKA.**

Your efforts have helped make Africa the Centre of the Universe.



TW Kambule Award

The big idea of small things

By helping electrons move faster across networks, this research team can solve developing countries' problems

Iwan Pienaar

The process of communication has been rapidly evolving with data and video now part of the mix. There's an increased number of smart phones and tablets and in many developed countries, communicating with video and very large files is the norm. Professor Saurabh Sinha says it is estimated that the amount of data being transferred wirelessly will be in the seven exabytes range per month by 2015. To give an idea of size, one exabyte is a billion bytes. Sinha, who has a PhD in electronic engineering, is the director of the Carl and Emily Fuchs Institute for Microelectronics (Cefim) and group head of electronics and microelectronics in the department of electrical, electronic and computer engineering both at the University of Pretoria (UP). Your cellphone won't need you Near-future scenarios see your cellphone communicating with household appliances from outside the home. Sinha says it may get to the

point where the phone records your behaviour and then executes actions based on typical patterns. This is also probable for large industrial systems such as inventory management being done automatically across wireless networks. It's the advent of the "Internet of Things", where it is predicted that non-biological objects will communicate with each other independently of humans. For all of this to happen, increasing bandwidth becomes a necessity. (Bandwidth refers to the telecommunication pipelines that convey data, voice and video.) This increased need for bandwidth means that radio spectrum has become a scarce commodity in many countries, and it's the reason that there is a call to look at other radio frequencies. Sinha's research and outputs consider the mechanisms to increase this pipeline, specifically through millimetre waves (mm-waves). Cellphones use frequencies around 900GHz, the licensed GSM range. Bluetooth and WiFi use 2.4GHz, unlicensed when it is used for low range (lower power). The mm-wave refers to extremely

high frequencies, such as the 57-64GHz and the 86GHz range. These are, in the most part, around 60GHz, unlicensed and available for use. The benefit is that the higher the frequency, the higher the data speed; however, atmospheric propagation becomes a challenge. "We want to communicate at faster speeds with a higher data rate but we don't want a large power supply - even though higher data rates require more power," says Sinha. "It's why the newer phone batteries don't last long. There is a trade-off against the faster data rate." More bandwidth higher frequency The focus is on faster data rates but using lower power. The use of higher frequencies to enable this advance is governed by the Shannon-Hartley theorem: if you want to increase capacity, you need to increase frequency. Sinha initiated the mm-wave integrated circuit research focus for the faculty of engineering, built High speed communication devices could go some way to resolving the technology gap that exists in developing countries

environment and information technology at UP. "Integrated circuits" refers to creating microchips. Thus the miniaturisation of wireless devices using mm-waves is about achieving greater frequencies and more data throughput, but with lower power. Through Sinha's international, national and regional networks, he has attracted over R10-million of funding to support the new state-of-the-art mm-wave laboratory, as well as over 20 postgraduate students and postdoctoral fellows. Developed countries are crying for increased bandwidth with faster data rates, but so are developing countries. However, the latter need this to address social challenges. "That is where we envisage our technology. Benefitting local communities "We want the fundamental research to have an impact on the information and communications technology backbone allowing for high-speed communication, particularly for rural communication," says Sinha. "While there are commercial applications, our initial focus is on developing countries." He says that the use of mm-waves is not a new concept but it was never realised because the silicon-based technology didn't exist. That is not

the case today. The new technology has created new research gaps which Sinha and his research are addressing. The mm-wave integrated circuit research involves international collaboration and not just with other researchers. With newer and miniaturised technology, Cefim has a "fabless" approach. This means that the very expensive prototyping and manufacturing processes are no longer done in-house. The approach allows local researchers to conduct research and development based on powerful simulation platforms. The development is grounded in cooperation with international foundries (manufacturers), including IBM and STMicroelectronics. Testing (measurements) is done in South Africa. "Because of the measuring facility and other state-of-the-art equipment, we are able to attract people from all over the world to do research," says Sinha. Modifying technology to yield high performance The unique approach followed by Sinha and his research team makes use of a cost-competitive silicon-based technology (SiGe). The team is using the SiGe technology node with certain ceramic

CONGRATULATIONS  
You have made us proud!

The Council for Scientific and Industrial Research (CSIR) is proud to congratulate its finalists at the 15th NSTF-BHP Billiton Awards 2012/13.

Dr Keith Ferguson; Dr Lucia Steenkamp and Prof Paul Steenkamp; and Dr Phillip Loveday have been honoured as finalists for their respective contributions to science, engineering, technology and innovation through research.

Dr Ferguson, a chief engineer at the CSIR, was the team leader of the Adaptive Real-Time Internet Streaming Technology (ARTIST) project. The ARTIST project was a collaboration between the CSIR, the University of Cape Town and East Coast Access that has led to the development of a new technology platform that enables viewers to watch live content on their mobile devices without interruption to the video stream, even at very low connection speed.

Dr Steenkamp worked with Prof Paul Steenkamp in the Biodx project to develop a 'green' disinfectant product found to kill 99.9% of bacteria and other micro-organisms in a very short time. The product is chlorine free and is non-toxic.

Dr Loveday, together with Francois Burger from the Institute for Maritime Technology, was the leader of a team that developed the Ultrasonic Broken Rail Detection technology. This technology is a world-first and is able to detect rail breaks remotely and in real-time by sending and receiving high frequency sound along the rails. Operators can now receive real-time alerts enabling immediate action that saves lives, structural damage and money.



## TW Kambule Award

components (hybrid integration) to yield high performance communication devices. The silicon-based technology makes possible the realisation of mm-wave circuits.

"Think of a very narrow road that you want to cross at an increased speed. If you make the road narrow enough, you could jump across it," explains Sinha.

"If another person jumped towards you as you jumped, and pulled you across, your speed would increase further."

Sinha and his team are making the circuits very small, using nanometer integrated technology, and electrons jumping with germanium accelerate the electrons more quickly across. This translates to higher data rate speeds.

"Such high-speed communication devices could go some way to resolving the technology gap that exists in developing countries and aid grassroots-level applications such as telemedicine, e- and m-education," says Sinha.

In 2007, Sinha received the South African Professional Society of the international Institute of Electrical and Electronics Engineers (IEEE) Engineer of the Year Award. More recently, he received the 2010 University of Pretoria Laureate Award, the most esteemed alumni award.

He holds a number of high-level positions in the international IEEE

and, in 2009, developed an initiative called 'Engineering Projects in Community Service' (EPICS) within IEEE.

This was done in collaboration with Professor Kapil Dandekar of Drexel University, Philadelphia.

The EPICS programme uses university and pre-university teams, working with the IEEE, to tackle NGOs' missions with technology to deliver solutions for local communities.

Projects range from solar energy support for an orphanage in South Africa to wind-powered electrical supply for humanitarian field operations in the United States.

The programme has been rolled out in several countries and continents (Africa, South America and Asia).

The professor has also been involved in numerous conferences and presentations regarding his research, developed human research capacity and worked within policy advocacy across Africa.

**Professor Saurabh Sinha is the winner of the TW Kambule Award, sponsored by the NRF: To an emerging researcher for an outstanding contribution to SETI through research and its outputs – over a period of up to six years after award of a PhD or equivalent in research**



Prof Saurabh Sinha

## UCT congratulates our NSTF-BHP Billiton Research Awards Finalists

Seven University of Cape Town (UCT) scholars from six research units are finalists in the prestigious 2012/13 National Science and Technology Forum-BHP Billiton Awards' Programme. This year, the NSTF celebrates its 15th awards, which recognise, acknowledge and promote excellence in the South African research and development community.

The Annual NSTF-BHP Billiton Awards event, launched in 1998, is the flagship project of the largest and most prominent multi-stakeholder representative forum for Science, Engineering, Technology and Innovation (SETI) organisations in South Africa.

UCT has finalists in the following categories:

### To an individual for an outstanding contribution to SETI over a lifetime:

Professor Robert Millar, Director of the UCT/MRC Receptor Biology Group and Director of the Mammal Research Unit at the University of Pretoria; and

Professor Dan Stein, Head of the Department of Psychiatry and Mental Health and Director of the MRC Unit on Anxiety Disorders at the University of Stellenbosch.

### T.W. Kambule NRF-NSTF Awards: To an individual for an outstanding contribution to SETI through research and its outputs over the last 5 to 10 years:

Professor Graeme Cumming, Pola Pasvolsky Chair of Conservation Biology in the Department of Zoology; and Professor Karen Sliwa-Hahnle, Director of Hatter Institute for Cardiovascular Research in Africa, in the Department of Medicine, UCT and Director of the Soweto Cardiovascular Research Unit at the University of the Witwatersrand.

### To a researcher, for an outstanding contribution to SETI through research capacity development over the last 5 to 10 years: Professor Karen Sliwa-Hahnle

### To an individual or a team for an outstanding contribution to SETI through communication for outreach and creating awareness over the last 5 years:

The Aqualibrium Civil Engineering Team, which includes Associate Professor Kobus van Zyl of the Department of Civil Engineering.

### To an individual or a team for an outstanding contribution to SETI through research leading to innovation:

The Adaptive Real-Time Internet Streaming Technology (ARTIST) team (a collaborative effort between UCT, Professor Gerhard de Jager and Associate Professor Mqhele Dlodlo, the CSIR, and East Coast Access).



Professor Robert Millar



Professor Dan Stein



Professor Graeme Cumming



Professor Karen Sliwa-Hahnle



Professor Kobus van Zyl



Professor Gerhard de Jager



Professor Mqhele Dlodlo

*"Each candidate and project has already done UCT proud. But we are particularly proud of the work being done by these finalists in capacity building, mentoring and outreach, which are essential to the growth of the thriving research community we are working to establish."*

– Professor Danie Visser: Deputy Vice-Chancellor

University of Cape Town

www.uct.ac.za



## NSTF-BHP Billiton Awards



Tracy Cheetham SKA SA general manager: infrastructure and site operations



Willem Esterhuyse, MeerKAT project manager



Dr Adrian Tiplady, SKA site bid manager



# From South Africa to the stars

The team that put together the square kilometre array has changed the South African scientific landscape for the better

Debbie Schultz

In 2012, after 10 years of work by the South African and Australian Square Kilometre Array (SKA) site bid teams, the independent SKA Site Advisory Committee identified, by consensus, Africa as the preferred site.

Subsequently, on May 25 2012 the International SKA Organisation announced that the SKA would be shared between Africa and Australia to maximise investments already made at both sites.

The SKA will be the largest telescope in the world, 100 times more powerful and more sensitive than any other telescope to date. It is a radio telescope made up of arrays of dishes and collects radio waves from the universe.

Hosting the SKA will generate new research, attract youth into the science, engineering and technology (SET) field and promote South Africa as a primary scientific destination. It will push the boundaries of technology and provide answers to fundamental questions in physics, astronomy and cosmology.

Among other things, it will help us to understand dark energy and dark matter, how and when the first stars and galaxies formed and how they evolved over time.

Putting together one of the largest and most advanced scientific facilities ever built – one that will rank alongside CERN (European Council for Nuclear Research) in Switzerland – is no mean feat.

It takes a dedicated team with cross-disciplinary skills.

The global radio astronomy community conceived of the multi-national multibillion dollar project in 1991. The South African team started working on the SKA bid in 2002, developing a robust hosting plan.

**A joint commitment put South Africa on the map**

“Putting the bid together was a multi-stakeholder engagement. It included public and private sector organisations, civil society and private contractors, among other entities,” says Dr Bernard Fanaroff, project director: SKA SA Project. “We looked at what could be done realistically, at an affordable cost, with minimised risk and maximised performance.”

An “Initial Offer to Host the SKA” was submitted in 2003, followed by a detailed “Response to the Request for Proposals” in 2005.

One of the most important issues was the radio-quiet nature of the proposed sites. A radio frequency monitoring campaign spanning 12 months and 40 sites strengthened South Africa’s bid. In addition, the bid showed suitability with respect to weather, atmospheric conditions, cost, availability of infrastructure and more.

“The final 150-page bid and its 11 reports were submitted in September 2011. The full document with its detailed annexures was 27 000 pages long,” says Dr Adrian Tiplady, SKA site bid manager. He joined SKA SA in 2004 and played a significant role in the bid.

The South African bid for the SKA was a partnership with eight other African countries. When the second SKA phase is completed (around 2024), the telescope will comprise antenna stations in Namibia, Botswana, Zambia, Mozambique, Kenya, Ghana, Madagascar and Mauritius.

**Into the future with the SKA**

The SKA is a global project managed by the SKA Organisation based in England and with members across the world. All SKA member countries will participate in the management, design, development and construction; however, agreements and responsibilities are still in negotiation.

The project is in preconstruction phase until 2016, to develop technologies and designs for the telescope subsystems. Construction is expected to start in 2017.

At the time of the final bid submission, the SKA SA team had already built the XDM (experimental developmental model) demonstrator, an engineering prototype telescope (KAT-7) and had started on the design of the SKA precursor (MeerKAT). This was to demonstrate the country’s readiness to host SKA.

“KAT-7 worked so well that it’s now in demand as an instrument for science observations,” says Fanaroff.

The 64-dish MeerKAT telescope is now under construction, to be completed by 2016. It will form an integral part of SKA phase 1. Another 190 SKA dishes will be added in the Karoo during phase 1 from 2016 to 2019.

“The vision for MeerKAT is to be a world-class instrument that exceeds the originally specified baseline requirements,” says Willem Esterhuyse, MeerKAT project manager. He manages the design and construction of MeerKAT and also did so for KAT-7.

Esterhuyse says that key technological and scientific advancements have already resulted from the programme. He adds that there will certainly be technology spin-offs for more generic and commercial applications.

Historical spin-offs from radio astronomy include the invention of the wireless network and global positioning satellite networks.



Until the SKA is completed, MeerKAT will be the most sensitive radio telescope in the southern hemisphere and it will be available for scientific use.

The core of SKA will be constructed in the Northern Cape, about 80km from the town of Carnarvon. A radio astronomy reserve has been established, protected by the Astronomy Geographic Advantage Area Act.

“The KAT-7, MeerKAT and SKA are all green-fields projects,” says Tracy Cheetham, SKA SA general manager for infrastructure and site opera-

tions. “This means that the area had very little infrastructure.”

Cheetham is responsible for the design and delivery of the extensive infrastructure (roads, buildings, power, data). She provided the same for KAT-7.

SKA has followed a system engineering approach. “We implemented a series of prototypes and the lessons learnt in each case are then fed into the development of the next telescope. It’s a way to drive down risk,” says Cheetham.

**Creating opportunities for South Africa’s youth**

The SKA is intended to have a long operating lifespan, at least 50 years. It will open up numerous job opportunities, not only within the scientific arena. Consequently, there is a comprehensive human capital development programme.

The Youth into Science and Engineering Programme offers bursaries to students in engineering, mathematics, physics and astronomy at undergraduate and postgraduate levels.

“The intention is to attract and retain young people into SET, with a special effort to attract South African women and black students,” says Kim de Boer, general manager for people support and development, communications and project secretariat, SKA South Africa Project.

The overall programme operates from school to university level. New research groups have been established in university departments and a wide range of astronomy research is being supported. There is also academic collaboration with universities in the African partner countries and leading universities around the world.

“To date, the project has supported nearly 500 students and postdoctoral fellows, as well as five research chairs,” says De Boer. “Nowhere else in the world has a capacity development programme focused solely on radio astronomy, and at developing capacity across all levels – from artisans through to research chairs.”

In 2012, SKA SA was identified as a Special Integrated Project (SIP16), one of the 18 national infrastructure programmes.

**The SKA team won the NSTF-BHP Billiton award for an outstanding contribution to SETI through management and related activities over the last five to 10 years or less (One joint or team award)**



Dr Bernard Fanaroff, project director: SKA SA project



Kim de Boer, general manager: people support and development, communications and project secretariat



Stations in Africa



Research capacity development



Prof Lesley Cornish

Creating African science networks

The University of the Free State  
- pioneering new ways of thinking.

Prof Lodewyk Kock and Dr Marieka Gryzenhout, 2013 NSTF-BHP Billiton Award finalists, are part of a distinguished group of UFS researchers who contribute to the Science, Engineering and Technology fields.

**Prof Kock**, from the Department of Microbial, Biochemical and Food Biotechnology, developed an innovative imaging nanotechnology called Auger-architectomics. He succeeded in exposing cell structures in a new world of 3D and element composition architecture. His Auger-architectomics mapped previously-unknown cell inclusions within eukaryotic cells – considered a paradigm shift leading to vast implications for biology and medicine.

**Dr Gryzenhout** from the Department of Plant Sciences, studies plant-associated fungi. She uses morphological comparisons of fungal fruiting structures and combines it with phylogenetic studies through DNA sequence data. She initiated studies where DNA of microbes can be directly amplified and identified from environmental samples and applying these techniques in the ecological and plant pathological sense.

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Iwan Pienaar

**P**rofessor Lesley Cornish has been supervising or co-supervising students since 1990. While working at Mintek, she also co-supervised students at Wits and the University of the Western Cape, the latter under scarce skills. Prior to 2003, she had graduated five PhD students and eight MSc students, of whom one was black and six were female. Since then, she has graduated five PhD students and 13 MSc students, of whom nine were black and four were female. She was invited to take over the directorship of the DST/NRF Centre of Excellence in Strong Materials in 2007. Part of the purpose of the centre is to increase the number of South African students, especially black and female students. In 2008, there was a call from Carnegie to establish a sub-Saharan network in a number of fields, including materials. By using her own contacts and those of her colleagues, she was able to obtain five participating universities in South Africa, Namibia, Kenya, Nigeria and Botswana. The minimum was three, but Cornish wanted to spread the benefit as much as possible. This network was established in 2008 and started admitting students in 2009, and has been awarded an extension of funds up to 2016. She has been co-supervising a total of 12 Amsen students. The aim of Amsen is to develop the next generation of academics through collaborative research. There are 11 research

teams, around 28 academics involved and 20 students. Each student has at least two supervisors across the network and this allows for better supervision, improved access to equipment as well as the mentoring of less experienced staff during the co-supervision. The students are able to benefit from more supervisors and the less experienced members of staff can be mentored in student supervision, without the students being compromised by inexperienced supervisors. In this way, both the staff and students benefit. As part of their training, students write three reports, at least one presentation and a poster annually. When funds permit there is also a workshop where the Amsen staff and students come together and the students present their work. The students are also encouraged to publish their work. To date, Amsen has published 16 journal papers of which four has Cornish as a co-author. Each student project is unique in Amsen and although some of the projects fall under the same umbrella, the projects are actually stand-alone. Cornish is currently involved in co-supervising 10 of the 20 Amsen students. Each student project is different, based on original research and tailored to the particular African country where the student is undertaking his/her degree or their home country. Professor Lesley Cornish received an award in the category: To a researcher for an outstanding contribution to SETI through research capacity development over the last five to 10 years

About Amsen

The African Materials Science and Engineering Network (Amsen) is funded by Carnegie-IAS. Amsen was one of the five networks chosen from 48 applications and

includes a university each in South Africa, Namibia, Kenya, Nigeria and Botswana. The rationale is to develop the next generation of academics through collaborative research. There are 10 research teams, 29 academics and 20 students.



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NSTF-BHP Billiton Awards



Dr Robert Tshikhudo

Managing nanotech for real solutions

Iwan Pienaar

For more than a decade, Mintek has been at the forefront in developing gold nanotechnology. This has become the basis for the establishment of the Mintek Nanotechnology Innovation Centre (NIC) in 2007. In response to addressing socio-economic challenges facing South Africa through nanotechnology, the Mintek NIC was established primarily aimed at addressing national priorities

highlighted by both the national nanotechnology strategy and national research and development strategy. The Mintek NIC, led by Dr Robert Tshikhudo as centre director and Dr Makhapa Makhafola as chairman, has made significant progress in developing research platforms, promoting collaborative networks, addressing human capacity, establishing world-class research infrastructure, and developing innovative nanotechnology-based systems and

devices for health diagnostics and therapeutics and water treatment applications. Some of the nanomaterials and diagnostic prototype devices have reached the industrialisation and commercialisation stages. The Mintek NIC structure was built on the foundation of the national system of innovation to focus on driving South Africa's transformation from a resource-based economy towards a knowledge-based economy using nanotechnology. As such, Mintek NIC management has identified and established research platforms at three local universities, which in turn collaborate with others in the fields of water, biolabels, sensors and nanominerals research.

Management expertise

Tshikhudo manages a large consortium where the activities undertaken are collaborative in nature. He manages networks between science councils, higher education institutes, and industries that occurred within South Africa and abroad since the inception of the NIC. Tshikhudo has also played a role in establishing and coordinating research and development activities across five continents (Europe, South America, Africa, Asia, and the United States). Nationally, more than seven universities collaborate with the NIC. The purpose of these collaborations involves student exchange programmes, joint publications, research fellowships, and short-term visits to gain expertise in specific fields. Networking is an excellent mechanism for the NIC students to work with international experts in the scientific arena and being exposed to other students, laboratories, and equipment not available locally. This mechanism is beneficial by strengthening the local expertise base and know-how. NIC researchers have established more than 25 international collaborations throughout the world. Dr Tshikhudo not only handles the administrative and management roles but his PhD work on gold nanotechnology and diagnostics (which earned him national and internal awards) laid the foundation for the majority of work that is ongoing within and outside of the NIC. He coordinates most of the technical projects and works closely with local industry towards marketing, industrialisation, and commercialisation of NIC products. The strategic intent of the NIC is to be a global leader and a "one-stop-shop" in developing innovative nanotechnology-based systems and devices for rapid diagnostics and water treatment by 2025. The intention is to address national imperatives outlined in the ten year innovation strategy and play a critical role in socio-economic development using nanotechnology.

Dr Robert Tshikhudo is the winner of the NSTF BHP-Billiton Award, sponsored by Eskom to a researcher for an outstanding contribution to SETI through research capacity development over the last five to 10 years



Wits University is proud to honour our finalists in these awards, namely Professors John Pettifor, Neil Coville, Lesley Cornish, David Block and Karen Sliwa-Hahnle, all leading scientists in their field. These nominations are a testament to our 16 A-rated scientists some of whom work in our six Centres of Excellence towards breaking ground in Biomedical TB Research, Strong Materials, Aerospace, Advanced Drug Delivery Technology, Viral Gene Therapy, and Palaeosciences. Our research strengths are aimed at Biodiversity, HIV/AIDS, Evolution of the Species and National Heritage, Cities, Material Science and Engineering, Mineral Resources, Exploration and Mining, South Africa/India, Diseases of the Lifestyle, and Molecular Biosciences. Wits – one of only two African universities that continues to publish the most in ISI accredited journals.



## TW Kambule Awards

# Connecting the cosmos within to the cosmos without

It is a rare phenomenon to have an excellent record in research that is acknowledged internationally, and be able to communicate science to a wide range of audiences. The term “public intellectual” is one that fits Professor David Block.

His field of study is astronomy, in particular the morphology of spiral galaxies and the detection of cosmic dust in these galaxies. Block is currently a professor at the school of computational and applied mathematics and the director of the cosmic dust laboratory at the University of Witwatersrand.

Born in 1954, his scientific journey started as a teenager when Block's father recognised his passion for astronomy and bought him a telescope. Most parents would have considered the job done, but Block went on to build a fully-fledged observatory with a rotating dome in the family garden.

Elected a fellow of the Royal Astronomical Society of London at 19, he has organised four international astronomy conferences and is the only scientist in Africa to have his research appear twice on the cover of *Nature*, an international science journal.

However, he is quick to note that science is team-driven and he is privileged to have worked with some of the greatest minds of our age.

His academic endeavours are coupled with an ongoing desire to share with the public. “I don't want scientific discoveries locked away in journals. It's important for people outside of science to discover the magic,” says Block.

His public outreach started in 1976 and has been vast. He has had many radio and television interviews, nationally and internationally including a BBC documentary with the late Sir Patrick Moore and interviewing Professor Stephen Hawking during his visit to South Africa.

Block has organised various outreach programmes for schoolchildren and their teachers over the last 10 years. There are around a thousand children, typically from previously disadvantaged backgrounds, per event who are bussed to the University of the Witwatersrand where they are exposed to astronomy.

“I have been able to reach about 18000 schoolchildren just in the last five years,” says Block.

There is no formal programme behind these talks and Block organises everything from sponsorship to logistics.

“The mind is not a vessel to be filled but a fire to be lit,” says Block, paraphrasing the ancient Greek

philosopher Plutarch and explaining his motivation for connecting with the public.

“People today tend to lack enthusiasm and passion. It's why many of my talks, while in the context of science, are about the power of vision. It's so important to motivate our future leaders.”

He has also presented numerous public astronomy lectures over the years and invited distinguished international scholars to present to the public.

This ambassador for astronomy connects the wonders of the cosmos with the heart, eliciting a deeper sense of individual purpose. He refers to it as “linking the cosmos without to the cosmos within”. Beyond motivational, the exposure to science has also been a catalyst for youth to study in this area.

The latest book he published was a 2009 collaboration with Professor Freeman, who was named Australia's most distinguished scientist for 2012. *Shrouds of the Night* covers Block's life's work of unlocking the mysteries of cosmic dust in our universe.

Reaching beyond the traditional science framework, the book uses poetry, art, history, theology and science to appeal to a multi-faceted audience. He also wrote two other books for a public audience.

“I am deeply interested in the interplay between art and science because it's important to not only use one sector of the brain,” says Block. “Without this, scientists are missing out on what can be unlocked.”

He says that key insights might fall into place by, for example, studying Magritte's work *The Treachery of Images* that shows a pipe along with the words “Ceci n'est pas une pipe” (This is not a pipe).

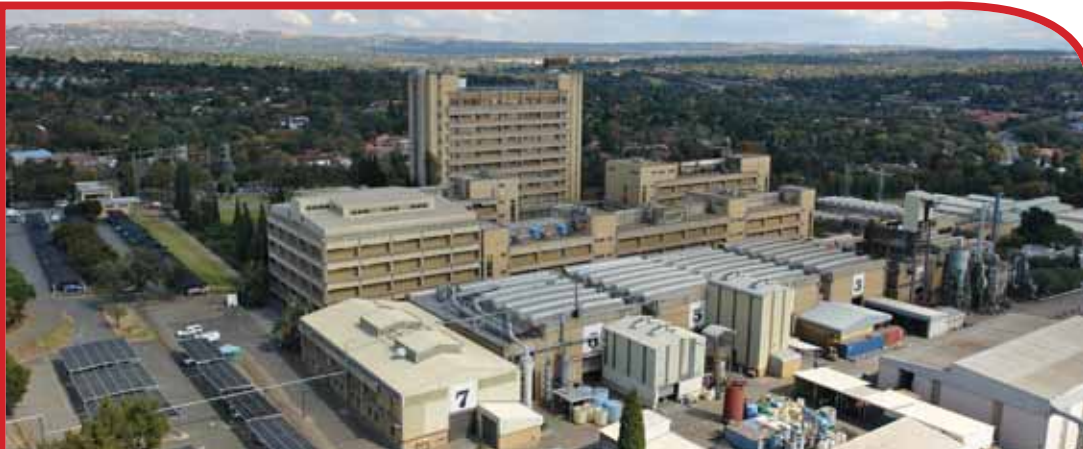
The work acted as a springboard for Block to look further into representation versus totality of experience, and to translate this into a scientific exploration of understanding the universe.

Block has been called South Africa's answer to Carl Sagan and was honoured by the University of Pretoria as *Lectori Salutem* for his “signal contribution to the promotion of Science and Scientific Education” in 1997. He also received the prestigious University of Witwatersrand's Vice Chancellor's Research Award in 2006.

**Professor David Block is the winner of the award science communication for outreach and public awareness, sponsored by the South African Agency for Science and Technology Advancement (Saasta)**



Director of the cosmic dust laboratory at the University of Witwatersrand Prof David Block



## The 15<sup>th</sup> NSTF BHP Billiton Awards recognise innovative Mintek staff



FOR ALMOST A CENTURY, Mintek has been at the forefront of minerals metallurgical research and development. Today, this centre of technological excellence, with its teams of highly trained and experienced scientists, engineers, researchers and specialists continues to build South Africa's resources and capacity by providing advanced technology for the more effective extraction, utilisation and beneficiation of our mineral wealth.

The innovative work of Dr Robert Tshikhudo, Head of the DST/MINTEK Nanotechnology Innovation Centre (NIC) and Mr Dominic Jordan, Engineer: Furnace Control within the Measurement and Control (MaC) division at Mintek; with the support of their teams and management, has earned them nominations as finalists for the 15th National Science and Technology Forum (NSTF) BHP Billiton Awards.

Dr Tshikhudo has been nominated in two categories, namely, Individual through management and related SETI activities and Research, for Research Capacity Development for the role he plays in developing research platforms, promoting collaborative networks and addressing human capacity through the DST/MINTEK NIC.

“Mintek has reinforced its obligation to developing technologies aimed at strengthening the competitiveness of the traditional mineral processing cluster and foster new opportunities within it,” said Dr Makhapa Makhafola, General Manager for Research and Development at Mintek. “This is what paved the way for the ground-breaking efforts of Dr Tshikhudo and Mr Jordan.”

Mr Jordan has been nominated under the category Research leading to an innovation by teams or individuals in organisations for the development and demonstration of a non-contact, vision-based, measurement of electrode slip for use with Söderberg electrodes used extensively by smelting furnaces in RSA (SlipCam). This prototype was successfully installed and demonstrated at an industrial test site.

Mintek would like to congratulate Mr Jordan and Dr Tshikhudo as the finalists for the 15th NSTF BHP Billiton Awards.

**Your partner in unlocking mineral wealth.**

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NSTF-BHP Billiton Awards



Dr Keith Fergusson

FACULTY OF SCIENCE  
UNIVERSITY OF JOHANNESBURG

The Faculty of Science at the University of Johannesburg congratulates **Prof James Darkwa**, Professor of Inorganic Chemistry, on his inclusion as a finalist for the 15th NSTF BHP Billiton 2012-2013 Awards given to Leading Scientists for Innovatively Creating new Knowledge.

Faster  
mobile  
broadcasts

Bandwidth solutions for developing countries stretch the reach of new media to areas that did not have sufficient internet access before

Iwan Pienaar

Africa has one of the highest mobile user populations in the world. However, the biggest challenge for users, content creators and advertisers has been the delivery of content caused by either under-developed telecommunication infrastructure or the high price for broadband access.

Low-rate fast adaptive real-time streaming technology (Artist) is one answer to this problem because it not only allows viewers to have an uninterrupted broadcast stream on their mobile devices, but it also opens up new opportunities for content creators and advertisers.

With a vision to develop an adaptive broadcasting solution for developing countries, Dr Keith Ferguson joined the Council for Scientific and Industrial Research (CSIR) in 2007 and put together a consortium comprising the CSIR, University of Cape Town (UCT) and East Coast Access (ECA) to develop the Artist concept into a commercial broadcast platform suitable for low network infrastructure networks.

In 2008, Ferguson secured a first round investment of R14.5-million over three years from the Innovation Fund (now the Technology Innovation Agency). In August 2011 the consortium completed the research and development phase of the product, which consisted of research, software development and commercialisation tasks, with the system software development and research tasks implemented in parallel.

An alternative to faster internet connection

The innovation behind the project addresses the need for internet real-time media broadcasting that is specifically designed to operate in congested and bandwidth constrained networks.

This project provides a set of solutions to each part of the delivery system such that these products and services can be universally available in both developed and developing environments.

The trouble with streaming and viewing content on any device is buffering caused by a disruption to the data stream.

Until recently, the best solution to this has been investing in faster

internet connections, which is expensive for broadcasters and users in emerging economies.

However, the Artist video content delivery technique has extended the concept of adaptive streaming to operate fast and at very low rates to not only urban areas but also to the rural African context.

The embedded advertising platform developed in this project creates a new approach for new media advertising agencies to access previously untapped market segments that have been constrained by internet access.

The core capabilities of the consortium have been combined into a full commercial-grade software server architecture that provides a very scalable delivery platform where the messaging or advertising is integrated into the video stream with full measurement capabilities.

The CSIR was responsible for the core media server software development, some video research and lead project management.

ECA was focused on the web server with integrated advertising development and piloting of the system. Finally, UCT was responsible for the supervision of the research of a PhD and four MSc students. The MSc research was directed at acquiring specialist skills for the implementation of the media platform, and two of these students were then employed at the CSIR upon completion of their studies.

In August last year, the consortium licensed the technology to Tuluntulu who is currently in the process of securing customers and raising investment for the business. Once a set of conditions has been met, the intellectual property will be assigned to the start-up in exchange for a 20-year royalty agreement which will be shared amongst the consortium partners and the Technology Innovation Agency.

Artist is the winner of the NSTF Award to an individual or a team for an outstanding contribution to SETI through research leading to innovation: in a corporate organisation or institution

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The trouble with streaming and viewing content on any device is buffering caused by a disruption to the data stream.

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## Research for innovation

# Raising the quality of South Africa's railways

Iwan Pienaar

Upgrading South Africa's rail infrastructure was highlighted as a priority by South African president Jacob Zuma in his 2011 opening speech of Parliament.

To this end, the Ultrasonic Broken Rail Detection (UBRD) system is making a major contribution towards securing this rail infrastructure.

It enables Transnet to prevent derailments that not only cause a loss of life but also result in millions of rands in damages to trains and railway infrastructure. The project team working on the UBRD system believes that the cost of one derailment could exceed the cost of installing UBRD over the total length of the 865km Sishen-Saldanha line.

When Transnet first looked into possible solutions for rail break detection, they narrowed the choice of technologies down to the field of ultrasonics and approached the Institute for Maritime Technology (IMT) for guidance.

The organisation was well positioned to assist Transnet, particularly in system design, electronics and signal processing. IMT approached the Council for Scientific and Industrial Research (CSIR), with its experience on ultrasonic transducer design and development for sonar applications, to assist it with identifying the best form of transducer to achieve long-range sound propagation in rails.

The existing technology base in sonar enabled the two organisations to assist Transnet in the development of the UBRD system.

### Overcoming challenges

For the UBRD system, a fundamental physical problem that had to be solved was how to achieve sound propagation over significant distances within the railway lines. This was initially achieved empirically with field experiments and was later improved through modelling and extensive field trial experimentation.

IMT has been the primary point of contact for the duration of the project with Transnet, and has been responsible for the overall system including its field testing.

The CSIR has been responsible for the ultrasonic transducer and its physical interaction with the railway line. There has been significant scope for innovative problem-solving in each of these areas.

For IMT this has meant responsibility for the system's user requirements, its configuration, overall reliability and integration. The CSIR

invested substantially in the know-how of the mechanical system that is formed by the transmit transducer, the railway line and the receive transducer.

The technology management division of Transnet Freight Rail has provided extensive support in the development of the UBRD.

Access to Transnet's facilities and relevant personnel was arranged for test and evaluation purposes, and input from the engineers with regard to operational integration issues was received on a regular basis.

### Remote viewing

Many methods are employed to improve the reliability and the time-liness of detecting rail breaks on railway lines throughout the world. However, most of these methods are applied at scheduled times resulting in extended periods during which rail breaks are not detected.

These methods are manpower intensive, expensive to execute and can interfere with train operations.

The project team felt that the time was right for the development of a system like the UBRD. Currently, it is the only field-deployed ultrasound system capable of real-time, remote and distributed rail-break monitoring.

An operator can therefore sit in a control room and view the integrity of many hundreds of kilometres of railway line situated in a different part of the country or world, all in real-time.

The UBRD system has advanced science, engineering and technology internationally by being the first truly long-range guided wave ultrasound monitoring system to be implemented.

The system demonstrated that long-range propagation can be reliably achieved in rails and that a monitoring system can be an effective solution to real-time detection of rail breaks.

### Local importance

The ability of the system to prevent derailments is of key significance for South Africa.

With trains being up to 3.7km in length and weighing up to 37 000 tonnes, such derailment events have been estimated to cost the economy R70-million each time it happens.

Prevention of these derailments can therefore secure substantial savings for the country.

Freight derailments require recovery of the damaged rolling stock and freight. It also involves removing the blockages from the line so other trains that are en route to the harbour can travel without issues.



Dr Philip Loveday

With a tight operation at the ports for the docking of vessels and their loading being interrupted, derailments can be seen to simultaneously impact numerous industrial operations at the same time, hence the large cost impact.

The team leaders are Dr Phillip Loveday, Materials Science and Manufacturing Operating Unit at CSIR, and Francois Burger, Institute for Maritime Technology.

The project team developed a world-first solution that detects

breaks on the heavy freight railway lines of Transnet. It is a tailored solution that prevents costly derailments of trains. The UBRD system is able to detect rail breaks remotely and in real-time by sending and receiving high-frequency sound along the rails.

Operators are now able to receive real-time alerts enabling immediate action that saves lives, structural damage and money. The positive impact of this solution surpasses conventional, manually intensive

inspection techniques. The system has great export potential and is currently undergoing tests on foreign rail networks.

**The Institute for Maritime Technology and the CSIR have won one of the two NSTF-BHP Billiton awards to an individual or a team for an outstanding contribution to SETI through research leading to innovation: in a corporate organisation or institution**



Science is wondrous, fascinating, breathtaking but it means little if nobody knows about it.

By encouraging excellence in the communication of science and scientific research to society, SAASTA aims to make it more accessible, and influence innovations, commercialisation and entrepreneurial opportunities that can benefit all South Africans. By bringing research findings to the people, we help them make informed decisions on science; influence science policy and help to make a difference.

As sponsor of the NSTF-BHP Billiton Award for Communication for Outreach and Awareness, SAASTA salutes the contributions made by all researchers, science journalists and communicators who strive to give science a voice. We congratulate Prof David Block, Professor of Applied Mathematics and Astronomy at the University of the Witwatersrand, on winning this award in 2013. As a science communicator, he has made astronomy accessible to the public for more than 30 years, authoring a number of books, engaging in numerous interviews by the media and conducting public lectures and outreach initiatives to schools all over South Africa.



Prof David Block

NSTF-BHP Billiton Award

A soaring performance

Jonker Sailplanes was formed in 2003 by Dr Attie Jonker, Uys Jonker, and Dr Johan Bosman with the goal of developing, manufacturing and selling gliders of the highest quality and performance to the international and domestic market. This was done after a six year basic research period in which the foundation was laid for the original 18m JS1. The design of the JS1C sailplane was based on this development work and

incorporated an in-house developed patent on airfoil design and included a new patent on the flow around the wing and fuselage junction. The flow analysis was performed by Bosman as part of his thesis work for his PhD while the structural design work was conducted by Dr Attie Jonker. Special attention was given to design a new crashworthy cockpit that would be stronger and provide better protection to the pilot than was previously possible.

The manufacturing and prototyping was conducted by the development team at Jonker Sailplanes under the direction of Uys Jonker. He was also responsible for the flight test programme and the development of new testing techniques. The key success factor for this project was the collaboration between Jonker Sailplanes and the North-West University, with funding received through the Technology and Human Resources Programme

(Thrip) of the Department of Trade and Industry. The approach The methods used throughout the JS1 and JS1C development programme was that of mathematical modelling performed on a computer. For the flow analysis, extensive modelling was done using computational fluid dynamics as is commercially available in the ANSYS FLUENT software. These

models enabled the research team to quickly investigate a large number of different designs in a fraction of the time it would have taken using wind tunnel experiments. This resulted in the development of the wing root suction system (currently being patented) as well as the cockpit air extractor system which is already patented. This was also critical in designing a new wing with the required improvement in performance.

The flight test programme was conducted by Jonker Sailplanes in conjunction with the South African Civil Aviation Authority and with help of the CSIR for the flutter testing.

**Flight performance** Small design changes and improvements were made that allowed the glider with its 21 metre wingspan to eclipse the performance of existing open class gliders with wingspans in excess of 26 metres. These solutions solve an age old problem of all aircraft flow separation at the fuselage wing junction. The solution is to suck away the excess air at the wing root and expel it at another point on the aircraft to reduce the overall drag. The root suction system works with the patented cockpit extractor system to provide the suction source. Another innovation was the development of an integrated jet turbine engine system into the JS1C fuselage which is able to retract and extend in 30 seconds. This allows the glider to return home safely in the absence of sufficient thermal to climb, but can also be retraced to create a pure glider without any drag penalty. The system was designed so that a single pilot action will deploy and start the engine without any additional input from the pilot.

**Future succes** The development of the JS1C glider has secured the future of Jonker Sailplanes as a commercially viable enterprise. The company currently employs 70 people in the aerospace industry. Supporting more than 400 people. Many of whom are from a disadvantaged background. Additionally, the manufacturing methods are labour-intensive and have a very low environmental impact.

The JS1 development team at Jonker Sailplanes won the NSTF-BHP Billiton Awards for an outstanding contribution to SETI through research leading to innovation in Small, Medium or Micro enterprises

UP congratulates our NSTF-BHP Billiton Research Award Finalists



UP is proud of the achievements of all our finalists

- **Prof Robert Millar**, Director of the Mammal Research Institute and the Medical Research Council (MRC) Receptor Biology Unit was nominated for making an outstanding contribution to SETI over a lifetime.
- **Prof Andrew McKechnie**, Professor of Zoology and Entomology; **Prof Marietjie Venter**, Professor and Director of the Zoonoses Research Unit, Centre for Respiratory Diseases and Meningitis at the National Institute for Communicable Diseases, Johannesburg; and **Prof Xiaohua Xia**, Professor of Electrical, Electronic and Computer Engineering, Director of the National Hub for Energy Efficiency and Demand-side Management, and Director of the Centre for New Energy Systems were nominated for making outstanding contributions to SETI through their research and outputs over the last five to ten years.
- **Prof Michael Pepper** from the Department of Immunology and Director of the Institute for Cellular and Molecular Medicine was nominated for his outstanding contribution to SETI through communication for outreach and creating awareness over the last five years.
- **Prof Olalekan Ayo-Yusuf**, Associate Professor and Head of the Clinical Unit, Community Dentistry; **Prof Wanda Markotter**, Associate Professor at the Department of Microbiology and Plant Pathology; and **Prof Saurabh Sinha**, Associate Professor at the Department of Electrical, Electronic and Computer Engineering, and Director of the Carl and Emily Fuchs Institute for Microelectronics were nominated for their contributions to SETI through their research and outputs over a period of up to six years after being awarded a PhD or equivalent qualification.



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