Research collaboration

2009-2010

A joint publication highlighting the research partnerships between Stellenbosch University, the University of the Western Cape, and the CSIR

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CSIR
our future through science

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Foreword

Prof H Russel Botman, Stellenbosch University Rector and Vice-Chancellor
Dr Sibusiso Sibisi, CSIR President and CEO
Prof Brian O'Connell, University of the Western Cape Rector and Vice-Chancellor

Strategic research partnerships between Stellenbosch University (SU), the CSIR and the University of the Western Cape (UWC) have been established in the context of our respective mandates. The purpose of these partnerships is to jointly undertake research and development as well as human capital development (HCD) that contribute to economic growth and address South Africa's developmental challenges.

Interventions in HCD are important because the growth of the South African economy and the pursuit of the national development agenda are being hampered by skills shortages (and inadequate quality) in some areas as outlined in several high-level government policies and frameworks. These include the Medium Term Strategic Framework; the 2010 Cabinet Lekgotla which articulated 12 outcomes that will reflect progress in achieving national priorities; and the New Growth Path focusing on job-intensive economic growth, an issue that was also emphasised in the January 2011 Lekgotla.

Responding to the country's development agenda requires a substantial increase in the number of scientists, particularly at postgraduate level, as well as the transformation of the profile of the science base in terms of demographics, with particular emphasis on increasing the ratios of black, female and young researchers. It also requires the dynamic involvement of dedicated professionals who aspire to create relevant knowledge through excellence in science and technology, and who value the strength of transdisciplinary research.

The partnerships between the CSIR and SU and between the CSIR and UWC have not only resulted in world-class research and new knowledge, but also in an enhanced human capital base. An enabling environment has been created to support even greater achievements and we look forward to the next phases in the respective research partnerships.

Overview

Prof Arnold van Zyl, Stellenbosch University Vice Rector (Research)
Dr Thulani Dlamini, CSIR Group Executive: Research and Development
Prof Ramesh Bharuthram, University of the Western Cape: Deputy Vice-Chancellor (Academic)

This research report showcases some of the outcomes of the research partnerships between the CSIR and Stellenbosch University, and the CSIR and the University of the Western Cape between July 2009 and December 2010. The collaborations under these partnerships are based mainly on the memoranda of understanding (MoUs) between the partners.

The partnerships have created opportunities for a significant number of researchers in the three institutions to contribute their complementary skills through joint projects which have produced a commendable number of joint outputs, such as peer-reviewed journal articles and conference proceedings. The joint R&D programmes have been facilitated by access to each institution's research infrastructure and facilities.

Contributions to the human capital development objectives of the three institutions include the training of CSIR students at the University of the Western Cape and Stellenbosch University, the involvement of CSIR staff in lecturing and student supervision, as well as honorary appointments to various positions.

We envisage that these collaborations will continue to grow and increase the capacity and impact of our institutions.

Executive summary in numbers

Research collaborations between the CSIR and SU, and between the CSIR and UWC were productive during the period July 2009 – December 2010 as the composite numbers (below) show. Indicators testifying to this include the number of strategic research programmes exceeding R1.5 million that were initiated and implemented during the reporting period; the number of researchers collaborating on joint projects; and the number of research outputs.

In addition to research collaboration, human capital development (HCD) is a focus of all three institutions.

Research collaboration is productive and has impact

9

Large-scale[1] strategic research programmes initiated and implemented

81

Researchers at the institutions collaborating on joint projects

66

Joint outputs[2] resulting from supervised and joint research

Advancement of HCD objectives of the CSIR and of South Africa

27

CSIR researchers lecturing/ supervising students

4

CSIR staff who hold extraordinary professorships

19

CSIR staff registered as students

48

Students registered and funded by joint projects

3

University staff appointed to CSIR research advisory panels

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[1] *Projects exceeding R1.5m*

[2] *Includes the following: (i) peer-reviewed journal articles, (ii) books, (iii) chapters in books, (iv) complete conference proceedings and (v) conference papers peer-reviewed.*



Contents

CSIR and Stellenbosch University strategic partnership

Introduction

This section of the report provides an assessment of of the activities that have been performed under the CSIR-Stellenbosch University MoU during the period July 2009 – December 2010.

The relationship has been developed and managed in the context of the mandates of SU and the CSIR, which emphasise the need for partnerships and alliances, and the development of human capital. The activities undertaken in this partnership reflect the mission of SU to be a research-driven university and its powerful credo 'Your Knowledge Partner'. The activities also support the CSIR's strategic objectives, particularly strengthening the science, engineering and technology (SET) base of the organisation and developing human capacity.

The current MoU between SU and the CSIR, which is valid until 2013, focuses on the following areas of collaboration:

- ICT – e-course development; wireless mesh; human language technologies (HLTs); Sign Language machine translation; sensor web and distributed sensing; ICT for unmanned aerial vehicles; knowledge technologies; high-performance computing; mobile technologies; and the 'Internet of Things'.
- Natural resources and environment – sustainability studies; invasion biology; resource economics; sustainable, renewable energy; environmental assessment and management; and groundwater and environmental microbiology.
- Laser technology – short-pulse lasers; modern optics; laser development; and laser-based applications.
- Built environment – planning; rural infrastructure; logistics; and supply chain management.
- Materials science and manufacturing – titanium research; polymer science; nanoscience; adipose-derived stem cells for use in gastroesophageal reflux disease (GERD) treatment; finite element modelling; micro-electro mechanical systems (MEMS); and electro-optics.
- Biosciences – molecular biomaterials.
- Human capital development – joint appointments, staff exchange, studentships, and co-supervision of students.

4

Large-scale strategic research programmes initiated and implemented

38

Researchers at both institutions collaborating on joint projects

46

Joint outputs resulting from supervised and joint research

24

CSIR researchers lecturing/ supervising students

3

CSIR staff who hold extraordinary professorships

17

CSIR staff registered as students

33

Students registered and funded by joint projects

1

University staff appointed to CSIR research advisory panels

Highlights and achievements

The following pages give a snapshot of the progress made in some of the joint CSIR and SU projects.

Natural resources and environment

Determination of pollution in the Upper Olifants catchment

Dr Paul Oberholster, CSIR • Prof Anna-Maria Botha Oberholster, SU

Background

Since 2008, Loskop Dam has experienced several incidents of sudden fish and crocodile deaths; this has also happened further downstream as far as the Kruger National Park. The water in the Upper Olifants catchment enters the Loskop Dam before it flows further down the Olifants River to the Kruger National Park and eventually Mozambique. The water in the catchment is subjected to various sources of pollution such as acid-mine drainage, pesticides, agricultural fertilisers, industrial waste, domestic sewage and atmospheric deposits.

Response

A multidisciplinary team of over 30 scientists has embarked on a three-year research project to assess the eutrophication and chemical pollution of the Olifants River, which is one of the most heavily used and also most polluted rivers in South Africa.

Funded by the Olifants River Forum, the research team is looking at aspects such as river health, fish and insect health and diversity, riparian vegetation, atmospheric deposits, water bacteria, water quality,

nanomaterials, isotope analysis and ecotoxicology in order to assess the ecological status and health of the river ecosystem.

Progress

Based on the interim results from this study and historical data of the catchment, the main stressors in the catchment are heavy metals and sulphates, originating from mining and industry, and nutrients and microbiological contaminants originating from poor sewage treatment and feedlots:

- Heavy metals like aluminium, iron and manganese were the most frequently detected and in the highest concentrations in both water quality and bioaccumulation samples. It appears that heavy metal accumulation occurs across all sites in the catchment, even in areas with low mining and industrial activity. Researchers are investigating whether acid rain could be responsible for mobilising heavy metals due to their unusual acidity.
- All the sites showed mild to heavy microbial contamination most likely due to untreated, or poorly-treated, sewage flowing into rivers and streams. The samples were contaminated by microorganisms in the form of bacteria, viruses and protozoan parasites such as *Salmonella, Shigella spp.* (causes bloody diarrhoea, high fever, abdominal pain but not vomiting), *Giardia* (diarrhoea), *Cryptosporidium* (long-lasting diarrhoea in immuno-compromised individuals), *Vibrio cholera* (severe diarrhoea and vomiting and possible death if not treated), as well as *Norovirus* and *Enterovirus* (diarrhoea). *E. coli* bacteria (an indicator of faecal matter in water) exceeded the South African water guideline values, indicating a high risk of diarrhoea.

Further collaboration

The following activities will receive priority:

- The research team has identified an appropriate reference site (the river following into Kranspoort Dam) against which data can be compared.
- Additional water quality data will be used to further refine the water quality signature of each site through the use of multi-variate statistics.
- Geographical information systems (GIS) will be used for a detailed assessment of land use for each site. These data will be used to link specific pollutants to specific land uses or impacts.
- Rain water will also be analysed for nano-materials.
- The study and analysis of the bioaccumulation of heavy metals in sediment and invertebrates will continue. All data will be compared to the results of the unique reference site.
- A mapping exercise of each sampling site will show how land-use activities have changed over the past 30 years.
- Indigenous sedge species will be tested for metal accumulation to determine whether they can be used to rehabilitate polluted wetlands.
- Continued monitoring of the microbial community of the catchment should shed more light on environmental and industrial effects to the Olifants River ecosystem.

Outputs

- *Peer-reviewed journal articles* **8**

30 scientists** have embarked on a three-year **research project** to assess eutrophication and **chemical pollution.

Laser science

Photonics research continues to grow

Dr Lourens Botha, CSIR • *Prof Heinrich Schwoerer, SU*

Background

Photonics is a growing research field internationally because of its potential value-add in areas such as light detection, illumination and displays, communications, data storage and processing, materials processing, medical diagnostics and surgery, security and defence. The CSIR National Laser Centre (NLC) and the Laser Research Institute (LRI) of SU have collaborated over several years on research in some of these areas and to train future researchers.

Response

Over the years, a number of CSIR staff at the NLC have studied towards their Master's and doctoral degrees at the LRI of SU under the joint supervision of researchers from both the CSIR and the university. Most of them have previously studied towards their undergraduate degrees at SU before being employed by the CSIR.

Furthermore, two NLC staff members are currently appointed as extraordinary lecturers in the Department of Physics at SU. The CSIR Group Executive: R&D has

also been appointed extraordinary associate professor and serves on the board of the LRI.

Different projects in laser development and laser science, which were based on student research, have been investigated jointly over the past 10 years.

Progress

An intensive programme dealt with the development of solid state lasers in the mid-infrared wavelength range, which is of interest for long-range laser propagation in the atmosphere. This programme has been moved to the NLC recently, together with three students and a postdoctoral student, after they completed their degrees at SU.

Most recent and current collaborative projects are in the field of ultrafast molecular spectroscopy, involving the development of short pulsed laser sources and their application in fundamental molecular chemistry and physics. The broader context of this work lies in molecular design studies for harvesting of light energy for solar cells; activation of molecular radicals for medical use; or all optical-sensing techniques for certain hazardous elements and substances.

The contribution of ultrafast spectroscopy is the understanding of light-induced chemical reactions at a microscopic level. Both the LRI and the NLC have established the required experimental infrastructure, and support each other with technical and scientific advice. These projects have led to a number of journal publications and many conference publications.

The LRI regularly participates in the NLC laser rental pool programme, and is one of the most active contributors to the African Laser Centre (ALC), a New Partnership for African Development (NEPAD) initiative currently managed by the CSIR.

Further collaboration

The LRI and NLC are the two main initiators and drivers of the envisaged Photonics Initiative of South Africa (PISA). PISA intends to coordinate all educational, R&D and industrial activities in photonics in the country to ensure that it plays a major part and benefits from the worldwide photonics revolution.

In future, the two institutions plan to establish a joint national laser research and training initiative. Through this, the human capital development and scientific aspects of PISA would be promoted within an academic environment, to provide broad and world-class training for future photonics specialists in the country. The success of this envisaged initiative will further strengthen the SU-CSIR partnership.

Outputs

- *Students trained* **10**

*In future, the **CSIR and SU plan** to establish a **joint national laser research** and **training initiative.***

Built environment

Annual State of Logistics™ survey informs decision makers

Hans Ittmann, CSIR • Dr Jan Havenga, SU

Background

The Annual State of Logistics™ survey bridges a knowledge gap by providing a view on the state of logistics in South Africa. It has become one of the premier references for logistics in South Africa as it creates opportunity for further discussions, interactions and dialogue on various logistics and supply chain management issues for managers, decision makers and policy formulators in the public and private sectors.

Response

The longstanding relationship between SU and CSIR Built Environment provided fertile ground for the development of the survey and includes private sector partner, IMPERIAL Logistics.

Progress

The survey was first published in 2004 and the team is currently undertaking the seventh survey (to be published 2011). The theme of the 2010 survey is 'Logistics value and costs – driving macro and

micro-economic change towards global competitiveness and sustainability'. The survey highlights the importance of the critical area of logistics and supply chain management in the world market-place and emphasises the value that can be derived from logistics.

Freight is still predominately transported by road and this is unlikely to change in the near future. A number of new issues are raised and elaborated on in this survey, for example, the effect of bad roads on the cost of logistics and humanitarian logistics. The survey found logistics costs relative to gross domestic product (GDP) to be at their lowest level since the inception of the survey, with costs at R339 billion or 14.7% of GDP in 2008, compared with 15.9% in 2007.

Transport cost increases were also lower than in any of the previous surveys (transport costs increased by 2.4%, but still account for 50.4% of total logistics costs). Inventory carrying costs were once again much higher in 2008 and increased by 21.2% from the previous year, constituting 18.6% of total logistics costs.

In addition to publishing the survey results in the mass media, SU, the CSIR and IMPERIAL Logistics also produce research reports and articles from the work done for the survey, including conference papers and journal articles.

Outputs

- *Peer-reviewed conference paper* **1**

- *Research report* **1**

The State of Logistics™ ***survey highlights the importance*** *of the critical area of* ***logistics and supply chain*** *management in the* ***world market-place.***

Materials science and manufacturing

Developing a new industry: Investment casting of titanium alloys

Pierre Rossouw, CSIR • *Prof Dimitri Dimitrov, SU*

Background

Reducing global warming by using less fossil fuels is high on the international agenda. Lighter vehicles are one way of achieving this, and this has led to the focus on light metals such as titanium (Ti). This project aims to establish local technologies and research centres that can compete internationally. The fact that South Africa has the second largest supply of raw Ti in the world is a further motivation for the initiative.

Response

The Industrial Engineering Department of SU and CSIR Materials Science and Manufacturing worked on an Advanced Manufacturing Technology Strategy (AMTS), which led to the development of investment casting capabilities. The AMTS is managed by the CSIR and funded by the Department of Science and Technology (DST). Although investment casting technology exists,

it is still at an emerging stage in South Africa for materials such as magnesium and Ti. Therefore, it is important for the AMTS to continue supporting the development of this capability to enhance South Africa's industry.

Progress

Ti is a very difficult and time consuming material to machine and much focus is placed on investment casting of intricate parts. The vacuum casting machine at the CSIR has been modified to cast Ti – a first for South Africa.

Various process chains have been established by using rapid prototyping techniques for investment casting, called rapid investment casting (RIC). A number of layer manufacturing technologies available in South Africa have been used for the study and compared in terms of achievable accuracy, surface finish and economics.

Through this project, researchers have been trained in new scarce skills for the South African market. As a result of these skills, new technologies and the establishment of research centres, the country should become globally competitive in the field of investment casting of metal alloys.

Further collaboration

The project has been successful and was extended for another six months. Further research includes the use of the CSIR's newly-established chemical milling lab to study the removal of the oxidation layer on the Ti (after casting) and also by using laser ablation, available at the CSIR National Laser Centre.

Outputs

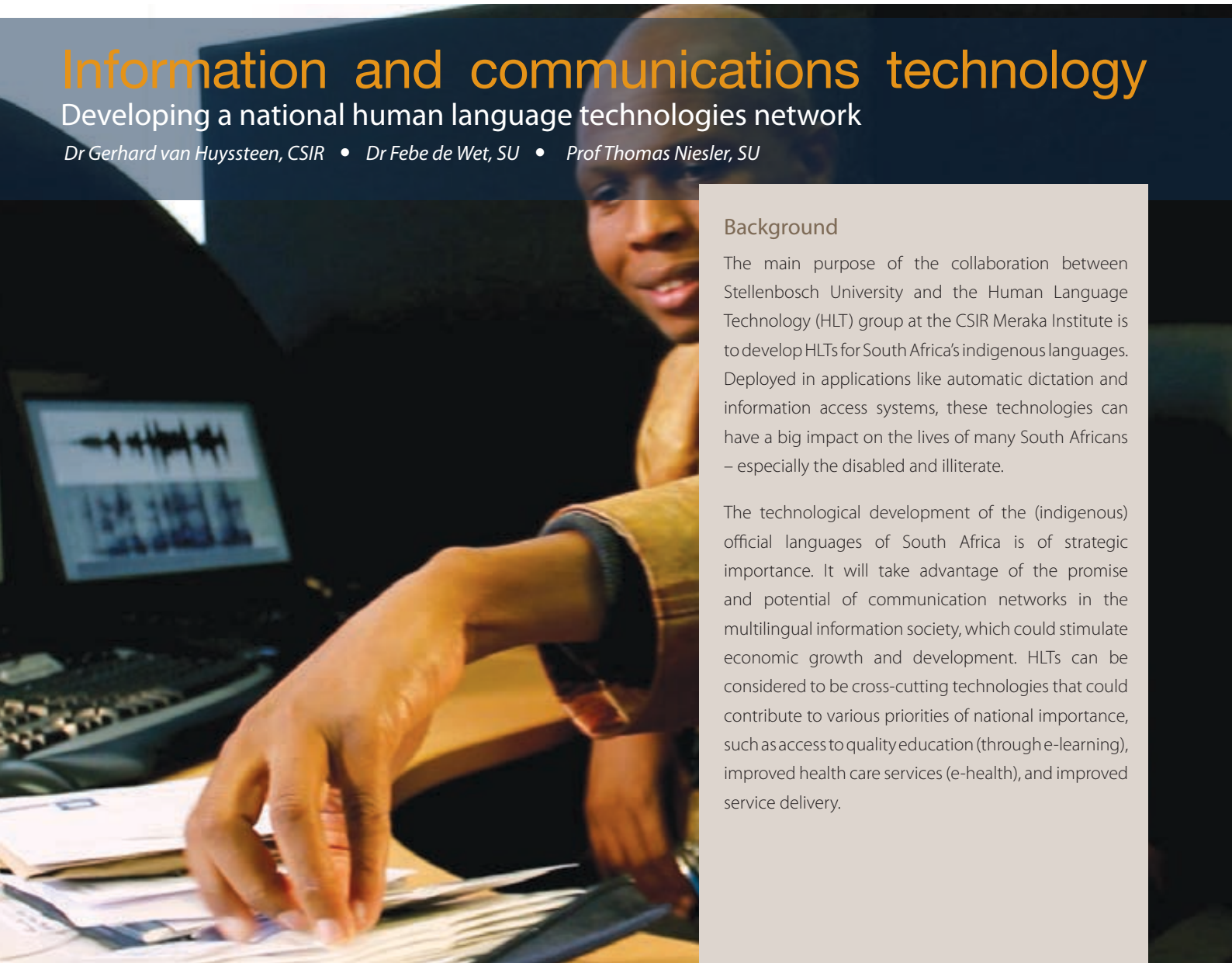
- *Research report* **1**

Lighter vehicles** are one way of **reducing global warming**, and this has led to a focus on **light metals such as titanium.

Information and communications technology

Developing a national human language technologies network

Dr Gerhard van Huyssteen, CSIR • Dr Febe de Wet, SU • Prof Thomas Niesler, SU



Background

The main purpose of the collaboration between Stellenbosch University and the Human Language Technology (HLT) group at the CSIR Meraka Institute is to develop HLTs for South Africa's indigenous languages. Deployed in applications like automatic dictation and information access systems, these technologies can have a big impact on the lives of many South Africans – especially the disabled and illiterate.

The technological development of the (indigenous) official languages of South Africa is of strategic importance. It will take advantage of the promise and potential of communication networks in the multilingual information society, which could stimulate economic growth and development. HLTs can be considered to be cross-cutting technologies that could contribute to various priorities of national importance, such as access to quality education (through e-learning), improved health care services (e-health), and improved service delivery.

Response

In addressing the needs mentioned earlier, the combined strengths of SU's Centre for Language and Speech Technology (SU-CLaST) and the HLT group at the CSIR Meraka Institute were employed. Although SU-CLaST was dissolved at the end of 2010, CSIR collaboration with SU continues through HLT researchers at the Department of Electrical and Electronic Engineering at SU.

The project mentioned here aimed to develop resources for Intelligent Computer-Assisted Language Learning (CALL). SU was specifically involved in research on automatic assessment of oral proficiency and listening comprehension, using automatic speech recognition (ASR) technology. The CSIR was involved in developing various tools and technologies that could support this capability.

Progress

The results of this project have been published in international journals and have also received coverage at various international workshops and conferences. The project members have been approached by a European consortium to participate in an Framework Programme 7 (FP7) proposal.

The project is expected to deliver tools that can be used by other groups interested in similar research. For example, the CSIR Meraka Institute has used software developed at SU to fast-track the development of a proof-of-concept demo for a potential industrial partner, interested in the development of an automatic pronunciation assessment system.

Further collaboration

A further deliverable is an operational system at SU that will be part of students' overall assessment, especially the language assessment component of the access tests taken by all potential first-year students.

Outputs

- *Peer-reviewed journal articles* **2**

- *Conference papers* **6**

Human language technologies
can have a ***big impact*** *on the*
lives of many ***South Africans -***
especially the ***disabled and illiterate.***

The following activity does not form part of the MoU between the CSIR and SU. However, it represents an important component of research collaboration in both institutions.

Other collaborative research activities

Autopilot development for unmanned aerial vehicle

John Monk, CSIR • Dr Iain Peddle, SU

Background

Unmanned aerial vehicles (UAVs) are currently used in a number of military activities. These vehicles are also increasingly being used in civil applications, security operations (such as police observation of civil disturbances and crime scenes as well as border patrol), reconnaissance support during natural disasters, powerline and oil pipe inspections and wildlife aerial surveys. UAVs are often preferred for missions that are regarded as too 'dull, dirty, or dangerous' for manned aircraft. UAVs are continuously being improved to perform these tasks, leading to the investigation of several challenges relating to flying wing and blended-wing-body configurations.

Response

UAV research collaboration between CSIR Defence, Peace, Safety and Security and SU's Department for Electrical and Electronic Engineering began in 2007 with a project aimed at stabilising and controlling a variable stability blended-wing-body aircraft, now well-known as Sekwa.

The CSIR was responsible for designing and building the aircraft with SU responsible for designing, building and testing an appropriate autopilot for the aircraft. The project was a great success despite problems encountered in flight trials, and it illustrated well how the two institutions can work together to solve complex UAV design and automaton problems. It was this success that led to further collaboration between the CSIR and SU in the form of the modular UAV project that started in 2008.

Progress

The modular UAV project had two parts. The first involved automating a 4 m wingspan modular UAV to provide South African research institutions with a national UAV test platform for further development, testing and maturing of UAV-related technologies. As with the Sekwa project, the CSIR was responsible for designing, building, testing and characterising the airframe, while SU was responsible for building, designing and flight testing the avionics and autopilot.

The project was a great success and showcased three successful 30-minute, fully autonomous flight demonstrations to the public: two in early 2009 at the White Hills radio flyers club and one in late 2009 as part of the flight demonstrations for the International Aerospace Symposium of South Africa (IASSA). The project also produced a Systems Integration Lab (SIL) at the CSIR where hardware-in-the-loop (HWIL) simulation and testing could be conducted to minimise flight risk when integrating new technologies.

The second focus of the modular UAV project was to perform research that could be applied to, and tested on, the modular UAV. The general theme of research under the modular UAV project was Fault Tolerant Control (FTC) of UAVs.

Further collaboration

This research will allow UAVs to continue to operate safely in the event of single failures in the system (typically actuator or sensor failures). The UAV should be able to identify that a failure has occurred, diagnose the failure quickly and accurately, reconfigure itself to work around the failure and continue to operate safely albeit in some cases with reduced performance.

Outputs

- *Research report* **1**

Unmanned aerial vehicles *are preferred for* ***misssions*** *that are seen as too* ***'dull, dirty, or dangerous'*** *for manned* ***aircraft***.

Human capital development

SU and the CSIR collaborate on human capital development

Pinda Sifunda, CSIR

Context of the collaboration

Apart from strengthening joint R&D, the MoU between SU and the CSIR also supports the development of human capital in order to realise a substantial increase in the number of SET professionals in the country.

Achievements

Twenty-four CSIR researchers lecture and supervise students, and serve as external examiners at SU. Three of the researchers have been appointed as extraordinary professors. These CSIR researchers provide support to students in areas such as biosciences, radar and lasers, ground water and environmental microbiology, environmental assessment, resource economics, HLTs, optronics sensor systems, knowledge representation and reasoning, human factors and enterprise engineering. A total of 18 Master's and nine doctoral students are being co-supervised with SU colleagues.

Testimonials

Eighteen CSIR staff members are currently pursuing Master's and doctoral degrees at SU. These students value their association with SU, as illustrated by the following accounts of their experiences:

"I am currently completing my MSc in electronic engineering at SU. The MIAS emerging research area at the CSIR has allowed me the use of autonomous platforms with which to conduct my studies under the supervision of SU staff, with my studies contributing significantly towards the development of the MIAS Autonomous Mule."

Michael Burke, CSIR Mobile Intelligence Autonomous Systems (MIAS) group

"My studies have been going well, primarily because of the good relationship between my academic supervisor at SU and my supervisor at the CSIR. Students can find themselves in an awkward situation if that particular relationship is not managed well. In my case, both supervisors are sensitive to how the different institutional systems (CSIR & SU) work and they help me navigate these systems."

Pumza Ntshontsho, CSIR Natural Resources and the Environment

"The feedback and consultation with my supervisor has always been constructive and positive. The Department of Geography and Environmental Studies has doctoral seminar days where research progress is showcased to doctoral students countrywide. A major advantage of studying at SU, while I'm working at the CSIR in Stellenbosch, is the close proximity of the university – it's literally a five-minute walk from my office!"

Manfred Spocter, CSIR Built Environment

"A complete and satisfying match was achieved between my PhD and the workplace – the outcomes progressively making an impact in remote sensing technology and geospatial products for both the CSIR and SU. Only these two institutions can facilitate such local advances in earth observation!"

Andre Breytenbach, CSIR Satellite Applications Centre

"I am doing an MBA, and I find SU's MBA programme to be quite balanced in all areas of management and leadership focus, while also instilling a strong research culture in students through assignments and case studies."

Mxolisi Miller, CSIR Enterprise Creation Development Unit

Future staff development

To further advance the collaboration on human capital development, SU and the CSIR will establish a scholarship fund to support postgraduate training in areas that are relevant to the MoU. This will help to achieve SU's postgraduate enrolment targets as well as the CSIR's objective of doubling the number of staff with doctoral degrees over the next five years.

Detailed indicators of collaboration

Large scale strategic research projects

Names of SU researchers	Names of CSIR researchers	Name of project	Research area as defined in the MoU	Budget
Prof Paul van Helden, Dr Andreas Diacon, Dr Bienyamen Baker	Dr Hulda Swai	TB nano drug-delivery system	Drug delivery systems	R6m
Dr Andrei Rozanov, Dr Willem De Clercq	Dr Nebo Jovanovic	Improved quantification of groundwater recharge, preferential flow and evapotranspiration	Water	R2m
Prof Anna-Maria Botha	Dr Paul Oberholster	Determination of pollution in the Upper Olifants catchment	Water	R18.5m
Prof Dimitri Dimitrov	Pierre Rossouw	Titanium Centre of Competence & AMTS Lightweight Metals	Investment casting of titanium alloys	R2.8m

Researchers at both institutions participating in joint projects

Names of SU researchers	Names of CSIR researchers	Area of research	Alignment with the MoU
John van Breda	Dr Michelle Audouin, Dr Nebo Jovanovic	TSAMA HUB – establishment of a doctoral programme in complexity and sustainable development	Sustainability studies
Prof Dimitri Dimitrov, Nico Treurnicht	Pierre Rossouw. Kalenda Mutombo	Investment casting of titanium alloys	Materials sciences
Dr Rob Smith	Aletta Karsten, Ann Singh	Effects of low-level therapy in muscle contusion injury in vivo	Laser science
Prof Erich Rohwer, Dr Christine Steenkamp	Dr Lourens Botha, Dr Anton du Plessis	Pump probe spectroscopy	
Prof Heinrich Schroerer	Dr Lourens Botha, Dr Anton du Plessis	Time domain beam shaping of femtosecond laser pulses	
Prof Heinrich Schroerer	Laser Loan Pool	Femtosecond spectroscopy of molecules and solids	
Prof Erich Rohwer	Laser Loan Pool	Short-pulse laser development and non-linear optical applications	

Names of SU researchers	Names of CSIR researchers	Area of research	Area in the MoU
Prof Kim Jenkins	Dave Phelp	Coastal engineering (C-PoRT)	Built environment
Dr Jan Havenga	Hans Ittmann, David King	Logistics/Supply chain management	
Dr Iain Peddle	John Monk	Autopilot development for Unmanned Aerial Vehicle	Defence peace safety and security
Dr Riaan Wolhuter	Derrick van Wyk	Non-line of sight RF modulation techniques	
Prof Thomas Niesler; Dr Febe de Wet	Dr Gerhard van Huyssteen	Human language technologies	Information and communications technology
Prof Thomas Niesler	Prof Etienne Barnard, Dr Marelie Davel	National HLT Network	

Joint outputs resulting from supervised and joint research

Authors	Title of publication	Publication
MoU area: Natural resources and the environment		
Nobre AM; Musango JK; De Wit MP; Ferreira JG	A dynamic ecological–economic modelling approach for aquaculture management	African Journal of Biotechnology Vol. 9(51), Pages: 8791-8799 Dec 2010
Oberholster PJ; Botha A-M	Use of remote sensing and molecular markers to detect toxic cyanobacterial hyperscum crust: A case study on Lake Hartbeespoort, South Africa	African Journal of Biotechnology Vol. 9(51), Pages: 8791-8799 Dec 2010
Oberholster PJ; Myburgh JG; Ashton PJ; Botha A-M	Responses of phytoplankton upon exposure to a mixture of acid mine drainage and high levels of nutrient pollution in Lake Loskop, South Africa	Ecotoxicology and Environmental Safety Vol. 73(2010), Pages 326-335 Nov 2009
Roura-Pascual N; Richardson DM; Krug RM; Brown A; Chapman RA; Forsyth GG; Le Maitre DC; Robertson MP; Stafford L; Van Wilgen BW; Wannenburgh A; Wessels N	Ecology and management of alien plant invasions in South African fynbos: accommodating key complexities in objective decision making	Biological Conservation, Vol. 142(8), Pages: 1595-1604 Aug 2009
Simberloff D; Nunez MA; Ledgard NJ; Pauchard A; Richardson DM; Sarasola M; Van Wilgen BW; Zalba SM; Zenni R; Bustamante R; Pena E; Ziller SR	Spread and impact of introduced conifers in South America: lessons from other Southern Hemisphere regions	Austral Ecology, Vol. 35 (5). Pages: 489-504 Aug 2010
Bugan RDH; Jovanovic NZ; De Clercq WP; Helmschrot J; Fluegel W-A; Leavesley GH	A comparative analysis of the PRMS and J2000 hydrological models applied to the Sandspruit Catchment (Western Cape, South Africa)	Management of Natural Resources, Sustainable Development and Ecological Hazards II, Pages: 391-402 Dec 2009 Chapter in book
De Clercq WP; Fey MV; Jovanovic N	An overview of the salinisation problem in the Berg River catchment (South Africa)	Management of Natural Resources, Sustainable Development and Ecological Hazards II, Pages: 379-389 Dec 2009 Chapter in book

Authors	Title of publication	Publication
Rahlao SJ; Milton SJ; Esler KJ; Van Wilgen BW; Barnard P	Effects of invasion of fire-free arid shrublands by a fire-promoting invasive alien grass (Pennisetum setaceum) in South Africa	Austral Ecology, Vol. 34(8), Pages: 920-928 Dec 2009
Israel S; Engelbrecht P; Tredoux G; Fey MV	In situ batch denitrification of nitrate-rich groundwater using sawdust as a carbon source, Marydale, South Africa	Water Air and Soil Pollution, Vol. 204(1-4), Pages: 177-194 Nov 2009
Nobre AM; Musango JK; De Wit MP; Ferreira JG	A dynamic ecological-economic modelling approach for aquaculture management	Ecological Economics, Vol. 68(12), Pages: 3007-3017 Oct 2009
Brent AC; Kruger WJL	Systems analyses and the sustainable transfer of renewable energy technologies: a focus on remote areas of Africa	Renewable Energy, Vol. 34(7), Pages: 1774-1781 July 2009
Bugan RDH; Jovanovic NZ; De Clercq WP; Helmschrot J; Fluegel W-A; Leavesley GH	A comparative analysis of the PRMS and J2000 hydrological models applied to the Sandspruit Catchment (Western Cape, South Africa)	Second International Conference on Management of Natural Resources, Sustainable Development and Ecological Hazards: Ravage of the Planet 2009. Cape Town, South Africa, 15-17 December 2009
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Authors	Title of publication	Publication
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CSIR researchers lecturing/supervising students at SU

Name of researcher	Research area as defined in the MoU	Type of collaboration
Dr Esbeth van Dyk	Built environment	Supervision
Dr Petrus van Zyl	Biosciences	Supervision
Herman le Roux	Defence, peace, safety and security	External examination
Johan Smit	Radar	Supervision
Dr Anton du Plessis	Lasers	Lecturing and supervision
Dr Lourens Botha	Lasers	Supervision
Andre Theron	Natural resources and environment	Supervision
Dr Christine Colvin	Ground water and environmental microbiology; Environmental assessment & environment	Lecturing and supervision
Gerhadus Diedricks	Natural resources and environment	Supervision and external examination

Name of researcher	Research area as defined in the MoU	Type of Collaboration
Jac Wilsenach	Natural resources and environment	Supervision
Lara van Niekerk	Natural resources and environment	Lecturing
Dr Ndeke Musee	Natural resources and environment	Supervision
Dr Nebo Jovanovic	Sustainability studies	Supervision
Russel Wise	Resource economics	Lecturing
Dr Aurona Gerber	Knowledge representation & reasoning; Human factors & enterprise engineering / knowledge systems	Supervision
Dr Febe de Wet	Human language technologies	Supervision
Mario Marais	Living labs	External examination
Nelis Williers	Optronics sensor systems	Supervision
Dr Christoph Bollig	Lasers	Supervision
Dr Adam Goliger	Built environment	Supervision
Dr Bennie Broughton	Defence, peace, safety and security	Supervision
Dr Mike Burns	Sustainability science	Lecturing
Dr Michelle Audouin	Sustainability science	Lecturing
Chrisna du Plessis	Built environment	Lecturing

CSIR staff registered as students at SU

Name of CSIR staff	CSIR supervisor	SU supervisor	Research area
Dwain Dunn	Glen Snedden	Prof Theo Von Backström	PhD (Mechanical engineering)
Manfred Spocter	Dr Karina Landman	Prof Ronnie Donaldson	PhD (Geography)
Elmi Bester	none	Dr Johann Kinghorn	MPhil (Information & knowledge management)
Mpendulo Ginindza	none	Dr Alan Brent	MPhil (Sustainable development planning)
Andre Breytenbach	none	Dr Adriaan van Niekerk	PhD (GIS)
Mxolisi Miller	Alan Webb	Prof Wolfgang Thamas	MBA (Intern management resources & environment)
Maria Magdalena Botha	Dr Colin Kenyon	Prof Ian Wiid	PhD (Biochemistry)
Jessica Chamier	none	Prof Andrew Crouch	PhD (Chemistry)
Nomakhwezi Mzamo	Dr Ndeke Musee	Prof Chris Aldrich	MSc (Process engineering)
Phumza Ntshotsho	Dr Belinda Reyers	Prof Karen Esler	PhD (Conservation ecology)
Ryan Blanchard	Dr Patrick O'Farrell	Prof Dave Richardson	PhD (Botany)
Susan Taljaard	Dr Neville Sweijd	Prof Hannes van der Merwe	PhD (Integrated coastal management)

Name of CSIR staff	CSIR supervisor	SU supervisor	Research area
Luther TerBlanche	Dr Gerhardus Diedericks	Dr Francois Smit	PhD (Applied Maths)
Ludwig de Clercq	Dr Lourens Botha	Prof Erich Rohwer	MSc (Laser physics)
Nicolene Botha	Dr Lourens Botha	Prof Heinrich Schwoerer	PhD (Laser physics)
Oliver Collett	Dr Cristoph Bollig, Daniel Esser	Dr Lourens Botha*	MSc (Laser physics)
Michael Burke	None	Dr Japie Engelbrecht Dr Willie Brink Dr Kristiaan Schreve	MSc (Electronic engineering)

** In his capacity as extraordinary professor*

CSIR staff who hold extraordinary professorships

Researcher	Area of expertise
Dr Lourens Botha	Physics
Dr Thulani Dlamini	Catalysis
Dr Anton Du Plessis	Physics

SU staff who serve on a CSIR research advisory panel

Name of staff	Area of research expertise
Prof Emile van Zyl	Microbiology

CSIR and the University of the Western Cape strategic partnership

Introduction

The relationship between the University of the Western Cape and the CSIR has been formalised through an MoU that was signed in 2009. The remainder of this report gives an overview of some of the research highlights and achievements resulting from the collaboration. The MoU identifies several strategic focus areas aimed at strengthening the relationship – through R&D and HCD, namely:

- Materials science and manufacturing with a focus on metals and metal processing.
- Biosciences with a focus on pharmaceuticals and synthetic biology.
- Nanotechnology with a focus on modelling of nanomaterials.
- Environment management with a focus on water quality.
- Human capital development including staff exchange, joint bursaries and student supervision.

New developments and knowledge in these areas have the potential to improve health, accelerate economic growth, create sustainable jobs, strengthen skills and improve the lives of South Africans – goals that are important to both the UWC and the CSIR.

The focus areas are aligned to the CSIR's areas of impact and supporting technologies. The areas of impact are (a) health, focusing on nutrition and affordable novel treatments; (b) natural environment, focusing on wise use and a safe future; (c) energy, with a focus on alternative and renewable energy; (d) the built environment, with a focus on transport and human settlements; (e) defence and security; as well as (f) industry, with a focus on advanced manufacturing and mining. The supporting technologies are ICT, photonics, robotics, materials, biotechnology and research infrastructure.

The collaboration agreement also reflects the UWC's objectives with respect to its mission as a university committed to excellence in teaching, learning and research; nurturing the cultural diversity of South Africa; and to responding in critical and creative ways to the needs of a society in transition. The partnership between the CSIR and the UWC is, therefore, a key component of research and development as well as human capital development in both institutions.

5

Large-scale strategic research programmes initiated and implemented

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Researchers at both institutions collaborating on joint projects

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Joint outputs resulting from supervised and joint research

3

CSIR researchers lecturing/ supervising students

1

CSIR staff who hold extraordinary professorships

2

CSIR staff registered as students

15

Students registered and funded by joint projects

2

University staff appointed to the CSIR research advisory panels

Highlights and achievements

The following pages highlight the progress made in some of the joint CSIR and UWC projects.

Environmental management

Determining the effect of land use on salinisation in the Berg River catchment

Dr Nebo Jovanovic, CSIR • Theo Scheepers, UWC

Background

Since South Africa relies heavily on fresh water resources, the UWC and the CSIR are collaborating on a project which aims to determine the effect of vegetation/land use on soil and water salinisation in the semi-arid conditions of the Berg River catchment. The project is funded by the Water Research Commission and is a follow-up to a previous project on 'Land use impacts on salinity in Western Cape waters', which was completed in 2009.

Response

The main outcome of the research will be improved management of human-induced salinisation in the Berg River catchment and the development of criteria for regulating land use in terms of salt-generating capacity. As part of the research, the effects of different cropping systems/rotations on water infiltration, runoff and sediment mobilisation are being investigated at the experimental farm in Langgewens near Morreesburg (Department of Agriculture holdings). The Department of Water Affairs also contributed to the research through funding the drilling and establishment of monitoring boreholes for assessing the impacts of land use on groundwater levels and quality.

Progress

One MSc student from the UWC graduated during the project completed in 2009 and he is now a full-time researcher at the CSIR. One MSc student from the UWC is working on the current project. The experimental part of the research has been completed. The results obtained in field trials (infiltration and runoff from different land uses) serve to inform the development and calibration of large-scale hydrological models that are implemented in selected catchments of the Berg River basin to support water and salinity management. The students have benefited through focused research and by working in a multidisciplinary team of scientists.

The CSIR benefited through the strengthening of monitoring and modelling capabilities.

Outputs to date include technical reports, published papers and presentations at water-related workshops and conferences. The project has also created a link with international hydrological modellers (Friedrich Schiller, University of Jena) and strengthened the positive image of the UWC and the CSIR among water scientists on the international scene.

Partnering with Stellenbosch University

In a similar project, the CSIR is also partnering with Stellenbosch University (SU) to determine the best solution for managing the salinisation of the Berg River. Researchers involved were Dr Nebo Jovanovic, CSIR; Dr De Clercq, SU; and Dr Rozanov, SU.

Funded by the Water Research Commission as well as the National Research Foundation, through the SA-Germany bilateral programme, the research team set up intensive monitoring sites at the Langgewens Experimental Station of the Department of Agriculture; the Goedertrou catchment near Riebeek West; and the Voëlvlei Nature Reserve, managed by Cape Nature.

The team used the data collected at the monitoring sites to develop algorithms and input data sets for hydrological models such as the Precipitation-Runoff Modelling System (PRMS, US Geological Survey) and the J2000 from the Friedrich Schiller University of Jena in Germany.

Outputs

- *Peer-reviewed journal articles* **1**

- *Book chapters* **2**

- *Conference papers* **1**

- *Students trained* **2**

Materials science and manufacturing

Investigating the use of dye solar cells as an energy source

Dr Mkhulu Mathe, CSIR • Prof Dirk Knoesen, UWC

Background

The dye solar cell is one of the most economical solar cells to manufacture, but it still needs to be developed further to improve its efficiency as well as structural and electrical properties.

Response

A CSIR researcher working towards a PhD at the UWC's Physics Department studied the reverse bias occurring in Ruthenium-based dye solar cells.

Solar cells tend to behave differently when they are exposed to shade instead of sunlight. They reverse their electricity charge back into the cell and cause it immense damage through a process called reverse bias. To prevent reverse bias, solar modules have diodes built into their design. Dye solar cells are not as susceptible to damage from reverse bias but the boundary conditions should be clearly understood and defined. Modules can then be built at even lower cost. The researcher subjected dye solar cells to various reverse bias voltages and their efficiencies were monitored

with time. The degradation – as well as the regeneration – was plotted against time and the cells analysed. The PhD study was completed in September 2009.

Another CSIR researcher pursuing his doctorate at the UWC is investigating the use of titanium dioxide (TiO_2) nanotubes as base material in a dye solar cell. The nanoparticles currently used do not have the best electrical properties, and contribute towards the lower efficiency of the cells. The TiO_2 nanotubes have excellent electrical properties and will contribute towards a much higher efficiency.

The material is prepared at the CSIR using a catalytic two-electrode cell on a platinum grid. Analytical facilities at the CSIR and at the UWC are being used to determine measurements and properties of the grown films.

Progress

Initial reports have shown that dye solar cells that use nanotubes outperform traditional nanoparticle-based dye solar cells in terms of charge transport and, ultimately, light-to-electricity conversion efficiency. A study aims to determine the extent of the effect of voltage, time and electrolyte on the morphology of TiO_2 nanotubes.

Preliminary results showed that it is possible to control the outer diameter, wall thickness and length of these nanotubes by simply having accurate control over the mentioned experimental parameters.

Further collaboration

Future research will be aimed at investigating the effect of the structure of the TiO_2 nanotubes on their optical and electric properties, which is crucial in determining whether they will be suitable for use within dye solar cells.

Outputs

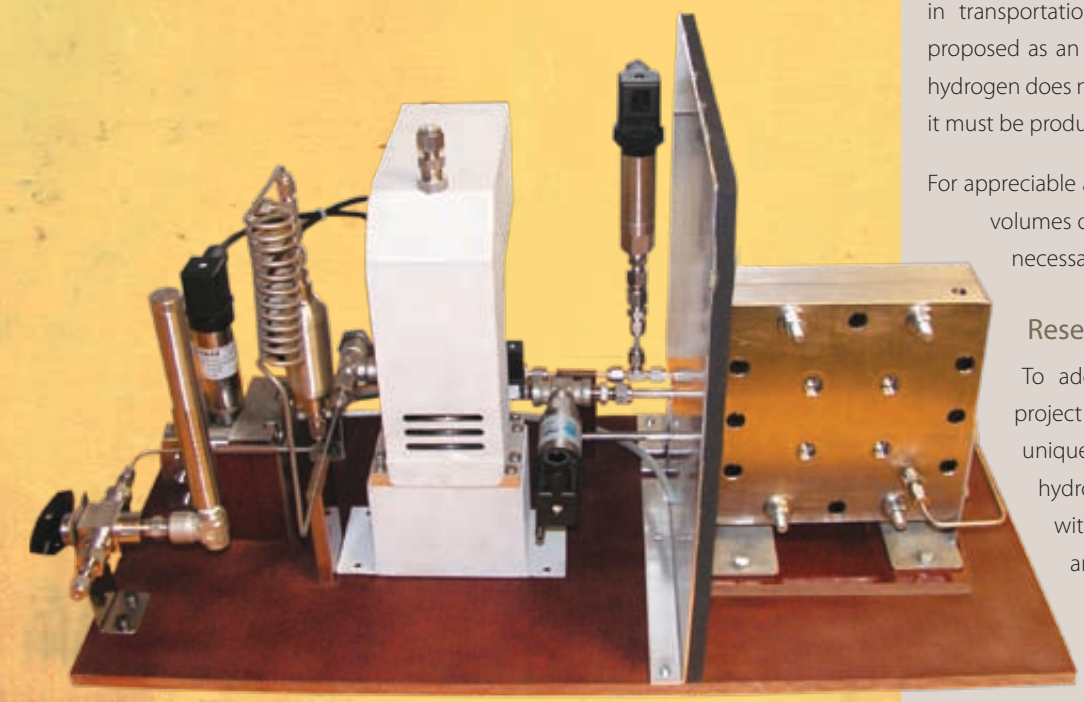
- *Students trained* **2**

*One of the most **economical solar cells** to manufacture, the **dye solar cell,** needs **further development** for **improved efficiency.***

Materials science and manufacturing

Developing a high-pressure electrolyser

Dawie van Vuuren, CSIR • Prof Vladimir Linkov, UWC



Background

The prospect of a decline in global petroleum extraction has necessitated research into alternative energy carriers, especially for mobile applications as in transportation. Worldwide, hydrogen has been proposed as an alternative energy carrier but as pure hydrogen does not occur naturally in quantity on Earth, it must be produced using other forms of energy.

For appreciable amounts of energy to be carried, large volumes of hydrogen are required. It is therefore necessary to store hydrogen under pressure.

Research

To address these needs, a joint research project by the UWC and the CSIR, which is unique in South Africa, has focused on making hydrogen directly under pressure. A system with a cell to convert water to hydrogen and oxygen at a pressure of 100 bar, thus approximately 100 times atmospheric pressure, has been developed. The

joint project is titled, 'Development of a solid polymer electrolyser for the production of hydrogen and oxygen under pressure'.

The UWC has developed the membrane and the electrical contacting material for the membrane electrode assemblies (MEA) and the electrolyser catalysts of the cell.

Complementary work by the CSIR has focused on the development of the high-pressure electrolyser cell, in which the MEA is placed between endplates that serve to contain the pressure, to introduce and distribute water, and to conduct electricity to the MEA. Hydrogen and oxygen are released by the process of electrolysis and kept separate by the membrane; hydrogen is dried and then stored.

The CSIR is also responsible for all the parts of the working system, which include the mechanical, electrical and control elements.

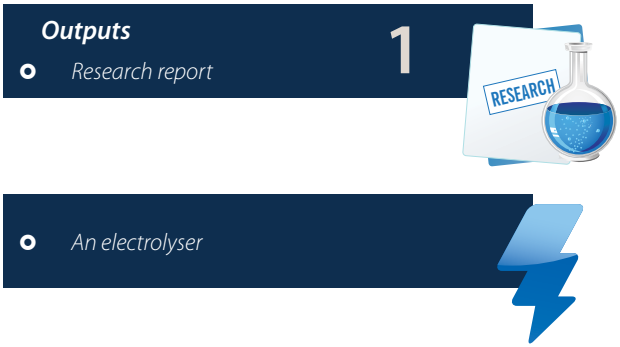
The resultant prototype has demonstrated that hydrogen can be produced at 100 bar, which means that it need not be compressed before storage.

The project has received funding from the Innovation Fund since January 2008.

Outputs

The laboratory prototype has provided proof-of-concept of the research and development to date. It will be scaled up to an engineering prototype as this research remains relevant for the future. Whilst fossil fuels are still relatively abundant, current applications are limited to niche applications such as back-up and remote power supplies, and research facilities.

Several students at the UWC have been involved in the project. Background intellectual property was developed with funding from Eskom.



The need for a hydrogen compressor to ***compress hydrogen*** *to reasonable pressures before* ***storing it is avoided.***

Nanotechnology

Organic photovoltaics: Low-band-gap polymers for photovoltaic applications

Dr Gerald Malgas, CSIR • Prof Christopher Arendse, UWC

Background

Most of the energy currently used is generated by burning fossils fuels. This contributes to emissions of carbon dioxide into the atmosphere, leading to global warming. An alternative to fossil fuels is renewable energy (such as wind, hydroelectricity, geothermal sources and solar). In particular, solar cells have potential because they do not generate noise and require little maintenance. However, solar cells are still relatively expensive and their conversion efficiency is low.

Response

The purpose of the research was to improve the overall efficiency and performance of an organic solar cell. The project is aligned with the National Nanotechnology Strategy as well as UWC and CSIR's research focusing on energy. The project will have national impact by offering a renewable energy source through the development of a low-cost, stable and efficient photovoltaic cell.

The project was initiated by the CSIR National Centre for Nano-Structured Materials (NCNSM) in 2007. Collaboration with the Department of Physics at the UWC commenced in 2009. The project also involves collaboration with researchers at CSIR Materials Science and Manufacturing, iThemba LABS and the Physics and Chemistry departments of the UWC.

Progress

Initially, the project focused on fabricating a low-cost, organic-based photovoltaic cell with a high efficiency, using low-band-gap organic semiconductor materials that have improved light absorption, charge transport and charge transfer properties. The emphasis has been on developing an understanding of the physics, chemistry, and materials science of these materials at a fundamental level and then to incorporate these materials into devices to help enable a new generation of scalable, low-cost photovoltaic technology. A low-cost deposition (spin coating) system that eliminates or reduces the need for high temperature and all high-vacuum processing systems has been set up.

Novel structures of polyaniline as well as polydimethoxyaniline were synthesised by an oxidative polymerisation process. The synthesised materials were characterised for morphology, elemental composition, structural properties and purity using high-resolution electron microscopy, energy dispersive x-ray spectroscopy, Raman scattering, UV-Vis spectroscopy, thermogravimetric analysis and electrochemical analysis. Buckminsterfullerene (C60) and Polyphenylquinoxalene (PPQ) were identified as an electron-charge transfer material. The electrochemical properties of polyaniline and polydimethoxyaniline were studied using cyclic voltammetry analysis. An article on this work has been published.

In the second year, P3HT/PEDOT/ITO/Glass bilayer and blended structures were prepared. Interfacial analysis and properties of rr-P3HT spin-coated onto glass substrates were investigated using SEM/TEM analysis, thermo gravimetric analysis (TGA), photoluminescence, Raman and UV-Vis spectroscopy.

The photoluminescence results showed a complete reduction of P3HT after mixing with C60 in a 1:1 wt. % indicating an effective charge transfer from P3HT to C60 while the TGA showed that the materials (rr-P3HT and C60) are of high purity. Two articles have been published in this regard.

Also in the second year, a laboratory-scale solar simulator and a Keithley 2420 I-V curve measuring system to do basic efficiency measurements were acquired. Consequently, the focus of this project shifted to the illumination of the solar devices to enable enhanced efficiencies and device performances.

One MSc student graduated in March 2010 and it is envisaged that one PhD and one MSc student will graduate in 2011. Two BSc students are currently involved in the project as research assistants.

*The project will have **national impact** by offering a **renewable energy source** through the development of a **low-cost, stable** and **efficient photovoltaic cell.***

Biosciences

Researching lignocellulosic enzymes for agricultural feedstocks

Dr Fritha Hennessy, CSIR • Prof Don Cowan, UWC

Background

Obtaining enzymes that can efficiently degrade lignocellulose will allow researchers to break down plant-based material to sugars that can be fermented to alcohols, which can in turn be used as biofuels. Therefore, this project aims to isolate novel enzymes from a variety of sources that can be used to degrade lignocelluloses.

Response

The task of the CSIR is to isolate enzymes expressed by the bacteria present in the hind guts of termites. This is being done by isolating total metagenomic DNA from the hind guts of termites, using this DNA to create a metagenomic library, and screening this library for cellulolytic activities. The UWC is isolating novel enzymes from extreme sources, particularly focusing on the isolation of thermophilic enzymes. Stellenbosch University is isolating eukaryotic enzymes through the generation of cDNA libraries from additional environmental sources.

The Lignocellulosic Enzymes for Agricultural Feedstocks (LEAF) project, which involves CSIR Biosciences, the UWC Institute for Microbial Biotechnology and Metagenomics, SU and the Cape Peninsula University of Technology (CPUT), is funded for four years (April 2009 to March 2013) by PlantBio (now part of the Technology Innovation Agency).

Researchers in the LEAF project use modern molecular genetic, metagenomic and metatranscriptomic methods to identify and produce new enzymes for use in the digestion of lignocellulosic biomass. Enzymic digestion using mixtures of different enzyme activities (exo and endocellulases, xylanases and other hemicellulases) is a critical pretreatment step in the use of lignocellulosic biomass as a carbon source for biofuels production.

Progress

The team has successfully generated a large insert metagenome and has screened it for a variety of enzyme activities. Targeted inserts have been subcloned to obtain smaller regions for sequencing. Additionally, some full inserts (of ~ 30 kb) have been sequenced using high-throughput sequencing and more than 80 positive clones across eight different enzyme classes have been identified. The researchers are currently doing small-scale high-throughput purifications of selected enzymes and preliminary characterisation.

One paper on the diversity of the bacterial population in the termite hindgut is under review and it is intended that aspects of this work will be presented at international and local conferences, and published in peer-reviewed journals.

Outputs

- *Peer-reviewed journal articles* **1**

- *Students trained* **11**

It will allow the ***break down*** *of* ***plant-based material*** *to sugars that can be* ***fermented to alcohols,*** *which can in turn be* ***used as biofuels.***

Biosciences

Towards the establishment of a Herbal Biosciences National Laboratory

Dr Vinesh Maharaj, CSIR • Prof James Syce, UWC

Background

The South African Herbal Science and Medicine Institute (SAHSMI) has acquired new, state-of-the-art laboratories on the UWC campus, part of which can be used to establish a Herbal Bioscience National Laboratory. This laboratory has the potential to contribute to the health and bioprospecting sectors in South Africa as it strives to scientifically and clinically unlock the value of indigenous medicines and remedies.

Response

The Drug Discovery and Development group of CSIR Biosciences had several discussions with the SAHSMI regarding the development of botanical products and herbal medicines. These discussions culminated in the signing of an MoU and a research collaboration agreement between CSIR Biosciences and the UWC.

The collaboration aims to achieve the following:

- The advancement of at least five current research concepts into proof-of-concept products ready for commercialisation;
- The creation of skills currently under-represented in the South African landscape; and
- The establishment of joint MSc and PhD programmes between the UWC and the CSIR.

Progress

The CSIR recently received funding through the Department of Science and Technology for product development of botanical extract of selected, widely-used medicinal plants. The CSIR has made available some of these funds for postgraduate training at the UWC and studies aimed at achieving the objectives of the collaboration. One of the plants, *Sutherlandia frutescens*, is currently being researched by both SAHSMI and CSIR Biosciences.

SAHSMI has grown rapidly as a result of its successful participation in national and international research programmes, and the worldwide trend towards natural health and healing. It hosts the International Centre for Indigenous Phytotherapy Studies (TICIPS) with a focus on African health care systems for HIV/Aids, infection and immune modulation, funded by the National Institutes of Health (NIH) in the United States.

The local institute focuses on research in herbal medicine, herbal chemistry, herbal nutrition, herbal pharmacology, herbal immunology and herbal biodiversity. This advanced research is underpinned by cutting-edge imaging, analytical, molecular, nano and super-computing technologies, with the aim of understanding the interface between traditional knowledge systems and empirical science. (Source: www.uwc.ac.za)

*This laboratory **has the potential** to contribute to the **health and bioprospecting** sectors in South Africa.*

Biosciences

Investigating natural plant compounds as biomarkers for anti-inflammatory and immune modulatory effects

Dr Paolo Meoni, CSIR • Prof James Syce, UWC

Background

The scientific and clinical understanding of the quality, safety and efficacy of herbal medicines and remedies used for HIV/Aids, TB, malaria, cancer, diabetes, etc., will contribute to the development of innovative treatments for these debilitating diseases.

Response

The main focus of the collaboration between the CSIR and the UWC is to investigate the nature and biological availability of natural chemical compounds responsible for health benefits in plants used as food supplements or in traditional medicine. The current study has concentrated on a few compounds from *Siphonochilus aethiopicus* and *artemisia Afra*, both plants traditionally used in South Africa for the cure of various ailments.

The understanding gained should provide useful information for future planned in vivo efficacy studies and, ultimately, clinical trials on traditional herbal medicines and derived pharmacological actives for inflammation and immuno-modulation.

Progress

At the UWC, part of the work to investigate the uptake of luteolin in aqueous extract of *A. afra* by Caco-2 cells is almost complete. The preparation of flavonoid-rich extract of *A. afra* and the assessment of the metabolic stability of luteolin and other flavonoids in *A. afra* extract in an animal microsomal system, is ongoing.

One PhD student and one Master's student are participating in the study at the UWC. Based on data generated in this project, a paper titled 'Uptake and Metabolism of Luteolin from *Artemisia afra* aqueous extract in Caco-2 cells' was presented at the Indigenous Plant Use Forum (IPUF) conference at the ARC Infruitec-Nietvoorbij Institute in Stellenbosch, in July 2009, and is currently being prepared for submission to a prestigious journal.

At the CSIR, progress on the extraction, chemical profiling and quantification of extracts of *A. afra* included the drying of plant material in an oven at 60 °C and then grounding the material to a course powder using a hammer mill. For each extraction procedure, 5-10 g of powdered plant material was extracted with dichloromethane/methanol (1:1) for 2-4 hours on a shaker. After filtering, the extracts were concentrated by rotary vacuum evaporation below 45 °C and then further dried in vacuo at ambient temperature for 24 hours. Stock solutions (5 mg/ml) of the extracts in acetonitrile/methanol (1:1) were prepared for HPLC analysis.

Further collaboration

The following activities will also be undertaken to complete the study:

- Extraction, chemical profiling and quantification of the biomarkers in extracts of the two plants (CSIR);
- Determination of the gastric, intestinal and metabolic stability of the marker compounds (the UWC and the CSIR); and
- Determination of characteristics of intestinal transport of the selected marker compounds (the UWC and the CSIR).

Outputs

- *Peer-reviewed journal articles* **1**

- *Conference papers* **1**

- *Students trained* **2**

Researchers investigate the ***nature and biological availability of natural chemical compounds responsible for health benefits in plants used as food supplements or in traditional medicine.***

Human capital development

The UWC and the CSIR collaborate on human capital development

Pinda Sifunda, CSIR

A substantial growth in SET skills is required to respond to South Africa's development agenda, with emphasis on redressing gender and racial imbalances. The UWC and the CSIR have sought opportunities that contribute to human capital development since this is a priority of both institutions.

In the past year, three CSIR staff members were involved in the co-supervision of seven students (four Master's and three doctorates), with one of them also offering a lecture on computational physics. Also notable are 15 students who registered at the UWC and are funded through CSIR-UWC joint projects.

Two CSIR staff members are enrolled at the UWC for their doctoral studies and are jointly supervised by UWC and CSIR researchers. One of them says the following about his experience:

"Through this project, I successfully published more than six publications in high-impact peer-reviewed journals. I have also completed and submitted my PhD thesis in one year and eight months. This was all possible because of the enduring supervision, patience, support, commitment and extraordinary trust I received from my supervisors (Dr Gerald Malgas [CSIR] and Professor Christopher Arendse [UWC])."

David Motaung, CSIR Materials Science and Manufacturing

The existing activities will be expanded further through the implementation of a joint scholarship programme from 2011. The programme will support full-time students registered for Honours, Master's and doctoral studies at the UWC, in areas where the institutions are collaborating.

"My lecturing involvement with the UWC aimed to explore the collaboration between the Centre for High Performance Computing and the UWC in terms of human capital development. In particular, to contribute to the development of a computational physics curriculum for undergraduate to postgraduate students, and to be able to supervise postgraduate students. As a researcher in industry, it is crucial to collaborate with higher education institutions to enable the supervision of students on collaborative projects, and to contribute to the advancement of research, development and technology innovation."

Dr Daniel Moeketsi, CSIR Meraka Institute

A substantial ***growth in SET skills*** *is required to respond to South Africa's* ***development agenda.***

Detailed indicators of collaboration

Large-scale strategic research projects

CSIR researchers	UWC researchers	Name of project	Research area as defined in the MoU	Budget
Dawie van Vuuren; Ashton Swartbooi; Martin Williams; Markus Coetzer	Prof Vladimir Linkov; Dr Bernard Bladergroen	Development of a hydrogen electrolyser system	Material science and manufacturing	R2.2m
Dr Liesbeth Botha; Dr Mkhulu Mathe; Brian North	Dr Oystein Ulleberg; Prof Vladimir Linkov; Dr Ben Bladergroen	Hydrogen SA	Material science and manufacturing	R3.2m
Dr Vinesh Maharaj	Prof James Syce	Drug discovery based on biodiversity and IKS	Drug-lead discovery	R2.3m
Dr Jeff Chen	Prof Catherine Cress	CHPC Flagship Project	Information and communications technology*	R1.6m
Dr Nebo Jovanovic	Theo Scheepers	Management of human-induced salinisation in the Berg River catchment	Water quality	R2.9m

* not in MoU

Researchers at both institutions participating in joint projects

Names of UWC researchers	Names of CSIR researchers	Area of research	Alignment with the MoU
Dr Quinton Johnson; Dr James Mukinda; Dr Wilfred Mabusela	Dr Paolo Meoni; Dr Vinesh Maharaj; Dr Paul Steenkamp; Nial Harding; Dr Gerda Fouche	Complementary medicines development	Biosciences
Prof Don Cowan	Dr Dean Brady; Dr Fritha Hennessy; Tina Ronneberg; Dr Konanani Rashamuse; Daniel Visser	Biorefinery	
Prof Christopher Arendse; Prof Emmanuel Iwuoha	Dr Suprakas Ray; Dr Gerald Malgas; David Motaung; Thomas Malwela; Dr Thembela Hillie	Organic photovoltics	Nanotechnology
Prof Dirk Knoesen	Dr Mkhulu Mathe; Dr Johan le Roux; Franscious Cummings	Dye solar cells	Materials science and manufacturing

Joint outputs resulting from supervised and joint research

Authors	Title of publication	Publication
Environmental management		
Somerset VS; Petrik L; Iwuoha E	Application of hydrothermal synthesised zeolites in the removal of cadmium, lead and arsenic ions from mine wastewater	Handbook of Zeolites: Structure, Properties and Applications, Pages: 18pp Dec 2009 (chapter in book)
Somerset VS; Iwuoha E; Hernandez L	Stripping voltammetric measurement of trace metal ions at screen-printed carbon and carbon paste electrodes	Eurosensors XXIII Conference, Lausanne, Switzerland, 6-9 September 2009, Pages: 1 279-1 282 Sep 2009
Somerset V; Baker P; Iwuoha E	Mercaptobenzothiazole-on-Gold Organic Phase Biosensor Systems: 3. Thick-Film Biosensors for Organophosphate and Carbamate Pesticide Determination	Intelligent and Biosensors, Pages: 185-204 Jan 2010 (chapter in book)
Somerset V; Leaner J; Mason R; Iwuoha E; Morrin A	Determination of inorganic mercury using a polyaniline and polyaniline-methylene blue coated screen-printed carbon electrode	International Journal of Environmental Analytical Chemistry, Vol. 90(9), Pages: 671-685 Aug 2010
Williams CR; Leaner JL; Nel JM; Somerset VS	Mercury concentrations in water resources potentially impacted by coal-fired power stations and artisanal gold mining in Mpumalanga, South Africa	Journal of Environmental Science and Health, Part A, Vol. 45(11), Pages: 1 363-1 373 Sep 2010
Babajide O; Petrik L; Amigun B; Ameer F	Low-cost feedstock conversion to biodiesel via ultrasound technology	Energies, Vol. 3(10), Pages: 1 639-1 703 Oct 2010
Nanotechnology		
Cummings FR; Le Roux L; Mutangwa N; Knoesen D	TiO_2 nanotube-based dye solar cell research in South Africa	Fourth Korea-South Africa Joint Workshop on Nanotechnology. Seoul, South Korea, 18-22 October 2009, Page: 20
Motaung DE; Malgas GF; Arendse CJ; Mavundla SE; Oliphant CJ; Knoesen D	Thermal-induced changes on the properties of spin-coated P3HT:C60 thin films for solar cell applications	Solar Energy Materials and Solar Cells, Vol. 93(9), Pages: 1 674-1 680 Sep 2009
Motaung DE; Malgas GF; Arendse CJ; Mavundla SE; Knoesen D	Structural and photo-physical properties of spin-coated poly(3-hexylthiophene) thin films	Materials Chemistry and Physics, Vol. 116(1), Pages: 279-283 Jul 2009
Arendse CJ; Malgas GF; Muller TFG; Van Heerden BA; Knoesen D	Thermal stability of the optical band gap and structural order in hot-wire-deposited amorphous silicon	Journal of Materials Science, Vol. 44(23), Pages: 6 333-6 337 Dec 2009
Oliphant CJ; Arendse CJ; Malgas GF; Motaung DE; Muller TFG; Knoesen D	Dual catalytic purpose of the tungsten filament during the synthesis of single-helix carbon microcoils by hot-wire CVD	Journal of Nanoscience and Nanotechnology, Vol. 9(10), Pages: 5 870-5 873 Oct 2009
Cummings FR; Le Roux LJ; Mathe MK; Knoesen D	Structure-induced optical properties of anodised TiO_2 nanotubes.	Materials Chemistry and Physics, Vol. 124(1) Pages: 234-242 Nov 2010

Motaung D.E, Malgas G.F, Arendse C.J	*Comparative study: The effects of solvent on the morphology, optical and structural features of regioregular poly(3-hexylthiophene): fullerene thin films*	*Synthetic Metals 160 (2010) 876–882 Feb 2010*
Cummings F; Le Roux L; Mutangwa N; Knoesen D	*Low-cost transparent solar cells: potential of titanium dioxide nanotubes in the improvement of these next-generation solar cells*	*CSIR 3rd Biennial Conference: Science Real and Relevant, CSIR International Convention Centre, Pretoria, 30 August-1 September 2010*
Mavundla SE; Malgas GF; Motaung DE; Iwuoha EI	*Physicochemical and morphological properties of poly(aniline-co-pyrrole)*	*Journal of Materials Science, Vol. 45(12), Pages: 3 325–3 330 Mar 2010*
Motaung DE; Malgas GF; Arendse CJ; Malwela T	*Investigation of the effects of substrate annealing on the properties of polymer blends*	*Materials Chemistry and Physics, Vol. 124(1), Pages: 208–216 Jun 2010*
Motaung DE; Malgas GF; Arendse CJ	*Correlation between the morphology and photo-physical properties of P3HT: fullerene blends*	*Journal of Materials Science, Vol. 45(12), Pages: 3 276–3 283 Mar 2010*
Biosciences		
Williamson DS; Dent KC; Weber BW; Varsani A; Frederick J; Cameron RA; Van Heerden JH; Cowan DA; Sewell BT	*Structural and biochemical characterisation of a nitrilase from the thermophilic bacterium, Geobacillus pallidus RAPc8*	*Applied Microbiology and Biotechnology Sep 2010*
Mongwaketsi N; Ndungu PG; Nechaev A; Maaza M; Sparrow R	*Ionic self-assembly of porphyrin nanostructures on the surface of charge-altered track-etched membranes*	*Journal of Porphyrins and Phthalocyanines, Vol. 14(5), Pages: 446-451 Jan 2010*
Materials science and manufacturing		
Zheng H; Petrik L; Mathe M	*Preparation and characterisation of porous poly(2,5benzimidazole) (ABPBI) membranes using surfactants as templates for polymer electrolyte membrane fuel cells*	*International Journal of Hydrogen Energy, Vol. 35(8), Pages: 3 745-3 750 April 2010*

CSIR researchers lecturing/supervising students at UWC

Name of researcher	*Research area*	*Type of collaboration*
Dr Anwar Vahed	*ICT for Earth observation*	*Supervision*
		External examination
Dr Daniel Moeketsi	*ICT*	*Supervision*
		Lecturing
Dr Gerald Malgas	*Nanoscience*	*Supervision*

CSIR staff registered as students at UWC

Name of CSIR staff	CSIR supervisor	UWC supervisor	Degree and subject area
David Motaung	Dr Gerald Malgas	Prof CJ Arendse	PhD (Physics)
Franscious Cummings	Dr Mkhulu Mathe	Prof D Knoesen	PhD (Physics)

Students registered at the UWC and funded by joint CSIR/UWC projects

Name of student	Area of research
Brian van Heerden	Organic photovoltaics
David Motaung	
James Mukinda	Complementary medicines development
Terisha Ramdayal	
Colin Ohloff	Biorefinery
Megan Oldale	
Lesley-Ann Matthews	
Randall Crisp	
Tshifhiwa Mamphogoro	
Xaio Ping Xu	
Rhulani Ngobeni	
Munaka Matshaya	
Rudzani Mutengwe	
Timna January	
Yu Gao	

CSIR staff who hold extraordinary professorships

Name of staff	Area of research expertise
Dr Kenneth Ozoemena	Chemistry

UWC staff members serving on CSIR research advisory panels

Name of staff	Area of research expertise
Prof Dirk Knoesen	Nanoscience
Prof Quinton Johnson	Herbal science and medicine

List of abbreviations

ALC	African Laser Centre
AMTS	Advanced Manufacturing Technology Strategy
ASR	Automatic speech recognition
CALL	Computer-Assisted Language Learning
CPUT	Cape Peninsula University of Technology
CSIR	Council for Scientific and Industrial Research
DST	Department of Science and Technology
FP	Framework Programme
FTC	Fault tolerant control
GDP	Gross domestic product
GERD	Gastroesophageal reflux disease
GIS	Geographical information systems
HCD	Human capital development
HIL	Hardware- in- the- loop
HLT	Human language technology
IASSA	International Aerospace Symposium of South Africa
ICT	Information and communications technology
IP	Intellectual property
LEAF	Lignocellusic Enzymes for Agricultural Feedstocks
LRI	Laser Research Institute
MEA	Membrane electrode assemblies
MBA	Master of Business Administration
MEMS	Micro-electro mechanical systems
MIAS	Mobile intelligent autonomous systems
MoU	Memorandum of understanding
NCNSM	National Centre for Nano-Structured Materials
NEPAD	New Partnership for African Development
NLC	National Laser Centre
NRF	National Research Foundation
PISA	Photonics Institute of South Africa
PPQ	Polyphenylquinoxalene
PRMS	Precipitation-runoff modelling system
R&D	Research and development
RIC	Rapid investment casting
SAHSMI	South African Herbal Science and Medicine Institute
SET	Science, engineering and technology
SIL	Systems integration lab
SU	Stellenbosch University
SU-CLAST	SU's Centre for Language and Speech Technology
TGA	Thermo gravimetric analysis
UAV	Unmanned aerial vehicle
UWC	University of the Western Cape

Acknowledgements

Prepared by

Eunice Ndeke (CSIR), Kagiso Keatimilwe (CSIR), Mawethu Nyakatya (SU), Maryke Hunter-Husselman (SU) and Vanessa Brown (UWC).

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CSIR: Dawie van Vuuren, Dr Gerhard van Huyssteen, Hans Ittmann, Dr Fritha Hennessy, Dr Gerald Malgas, John Monk, Dr Lourens Botha, Dr Mkhulu Mathe, Dr Nebo Jovanovic, Dr Paolo Meoni, Pierre Rossouw, Dr Paul Oberholster, Pinda Sifunda and Dr Vinesh Maharaj.

SU: Prof Anna-Maria Botha Oberholster, Dr Andrei Rozanov, Prof Dimitri Dimitrov, Prof Heinrich Schwoerer, Dr Iain Peddle, Prof Thomas Niesler, Dr Jan Havenga, Dr Febe de Wet and Dr Willem de Clercq.

UWC: Prof Christopher Arendse, Prof Dirk Knoesen, Prof Don Cowan, Prof James Syce, Theo Scheepers, and Prof Vladimir Linkov.

Others

CSIR human resource managers and strategic research managers/centre managers who provided additional information on the collaboration with universities and CSIR Strategic Communications & Stakeholder Relations.

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