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Annual Report
2007/08

CSIR

our future through science

Annual Report 2007/08

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Science: real & relevant

NASA	National Aeronautic and Space Administration
NBMCC	National Border Management Co-ordination Centre
NCPC-SA	National Cleaner Production Centre South Africa
NEPAD	New Partnership for Africa's Development
NIPF	National Industrial Policy Framework
NML	National Metrology Laboratory
NPA	National Port Authority
NSDP	National Spatial Development Perspective
NSI	National System of Innovation
NWU	North-West University
ORT	Optical radar tracker
OSS	Open Source Software
PFMA	Public Finance Management Act
PG	Parliamentary Grant
PMP	Plant-made pharmaceutical
R&D	Research and development
RAP	Research Advisory Panel
S&T	Science and technology
SAAF	South African Air Force
SADC	Southern African Development Community
SADERI	South African Defence and Evaluation Research Institute
SAEOS	South African Earth Observation Strategy
SAICE	South African Institute for Civil Engineers
SANDF	South African National Defence Force
SANERI	South African National Energy Research Institute
SANREN	South African National Research Network
SAPDM	South African pavement design method
SAPS	South African Police Service
SARMES	South African resource management and expert system
SASL	South African Sign Language
SET	Science, engineering and technology
SRP	Strategic Research Panel
SSA	Swaziland Sugar Association
TB	Tuberculosis
TEI	Tertiary education institution
the dti	Department of Trade and Industry
THEMIS	Time history of events and macroscale interactions during substorms
TIA	Technology Innovation Agency
TMG	Table Mountain Group
TT&C	Telemetry, tracking and command
UAV	Unmanned aerial vehicle
UK	United Kingdom
UN	United Nations
UNESCO	United Nations Educational Scientific and Cultural Organization
US EPA	United States Environmental Protection Agency
USA	United States of America
VC	Venture capital
WISA	Water Institute of South Africa
WSIS	World Summit on the Information Society
WWC	World Water Council
YESA	Young Engineers and Scientists of Africa

RP147/2008 ISBN: 978-0-7988-5575-4

Compiled by CSIR Communication
Production: Naledi Litho (011 807 3112) Layout and design: Creative Vision (011 622 8205)

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A real and relevant role

OVERVIEW BY THE CHAIRPERSON OF THE CSIR BOARD, MS NOBUSI SHIKWANE

In my capacity as Chairperson of the Board, I am exceptionally proud to introduce the CSIR's annual review and financial report for 2007/08. In the past year, the organisation again confirmed itself as a formidable player in South Africa's research and development (R&D) sector; it has proven the ability to respond to a complex set of expectations, delivering world-class work and making a real difference in critical areas of this country's socio-economic development. Through this, the CSIR has demonstrated a relentless and persistent focus on what its true mandate is and clearly established its relevance as a national science authority.

The CSIR has proven the ability to respond to a complex set of expectations, delivering world-class work and making a real difference in critical areas of this country's socio-economic development.

New research areas have been established to contribute not only to the knowledge economy, but also to further amplify the CSIR's response to national priorities and strategies. The first national nanotechnology centres were launched during 2007, with the CSIR National Centre for Nano-structured Materials focusing on materials and energy research. This denotes a significant investment in research infrastructure. South Africa's efforts in, for example, earth observation and exploration, and the situational awareness of unobservable environments will gain momentum with the CSIR's pursuit of research in mobile intelligent autonomous systems. The organisation further joined the ranks of global innovators exploring the new field of synthetic biology.

Despite a multifaceted role and location in the service delivery value chain, the CSIR keeps a close eye to ensure that all activities fit within the organisation's stated mandate. The end result of research conducted at the CSIR leads to improved socio-economic standing; through better roads, cleaner water, better manufacturing approaches, and improved access to information and communications technology.

Research output in the form of papers by its expert base has contributed hugely to the national knowledge base. A formal approach to managing thematic investment is another component of supporting the R&D spread and directing it to areas where it will have impact. Of equal importance was the establishment of a formalised means for dealing with intellectual property and technology transfer – either for commercial domains or for society.

Concluding remarks in the Organisation for Economic Co-operation and Development's survey of the National System of Innovation (NSI) states that science and technology and R&D are supported as priorities by the

South African government and that measures are in place to increase investment in innovation activities. At the CSIR, this is affirmed by an increase of interfaces with role players in the NSI, the results of which are demonstrated by new memorandums of agreement. These underscore the CSIR's status as a national authority that is well-adapted to work towards a common goal with stakeholders in the education arena, private and public sectors as well as international collaborators.

The CSIR remains a proud partner of various government departments, including its major stakeholder, the Department of Science and Technology (DST), and others such as the Department of Trade & Industry (the dti). Much of the CSIR's work contributes to the DST's grand challenges as contained in its 10-year plan, while other CSIR research domains have clear strategies in place for contributing to the dti's Industrial Policy Action Plan. We talk about our partners elsewhere in this report.

Sound governance practices have been borne out again by thorough auditing processes and have resulted in a clean audit report. Business operations, system improvements and service delivery are all designed to maintain and enhance the overall governance of the organisation.

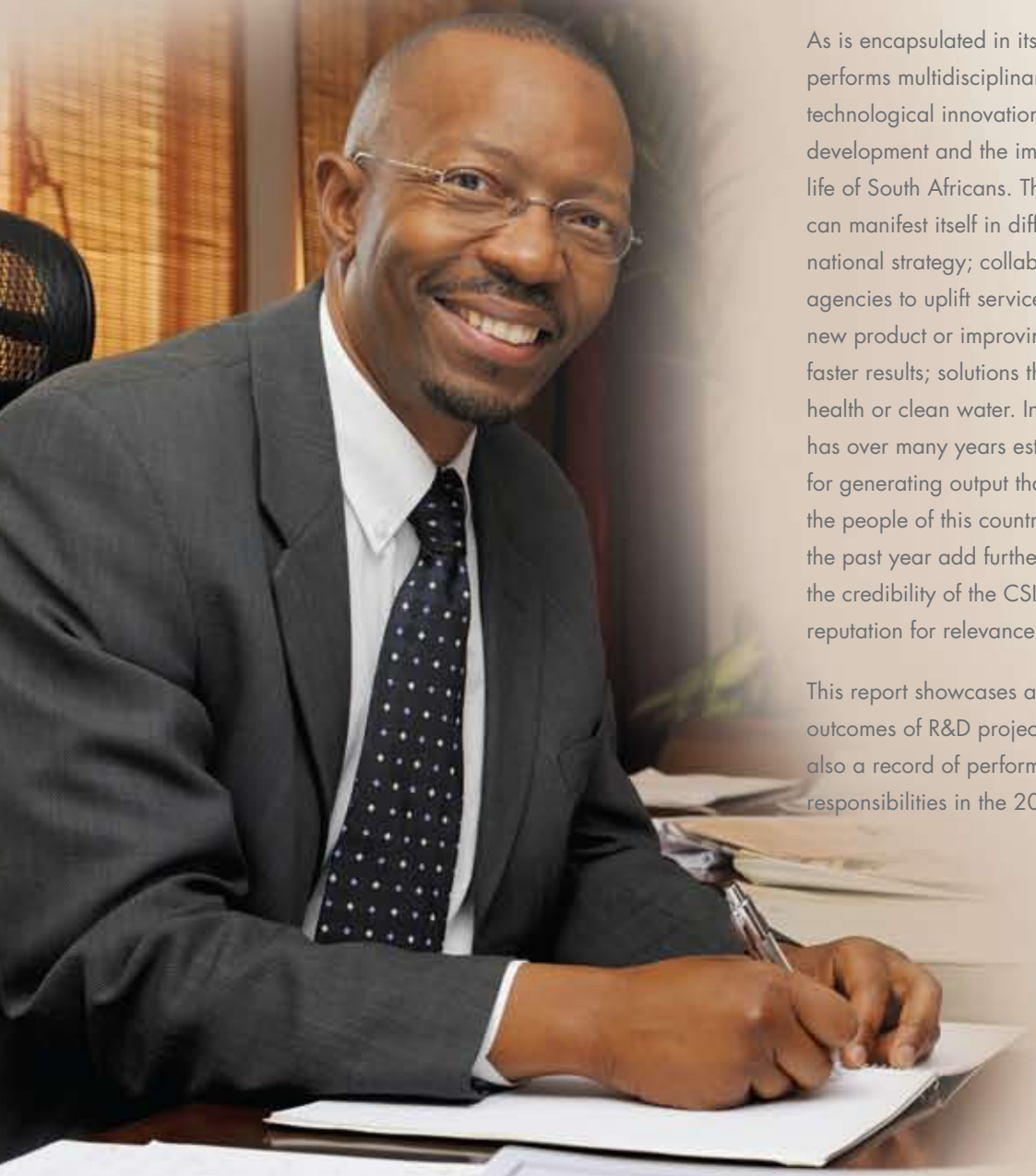
Annually at this time, reviewing the formal performance of the CSIR as well as perusing a showcase of projects, one is struck by the wealth of human talent resident in this organisation. Exemplary of this is the CSIR President, Dr Sibusiso Sibisi, who became a recipient of the National Orders (Order of Mapungubwe: Silver) in 2007 – the highest accolade a country can bestow on one of its citizens. The achievements of the CSIR's research core, the operational quality achieved by its support teams and the clear commitment and passion of its top management cadre, will continue to add to the organisation's national leadership in science excellence.

I would, lastly, like to convey my heartfelt gratitude to the CSIR Board, Executive team and staff. It is a privilege to serve with colleagues who are experts in their respective fields – all with a passion for seeing science make a relevant impact in the lives of others.

Chairperson's overview

A reputation for improving lives

INTRODUCTION BY THE CSIR PRESIDENT AND CEO, DR SIBUSISO SIBISI



The CSIR is a significant component of South Africa's research and development (R&D) sector and a key player in the country's National System of Innovation (NSI).

As is encapsulated in its mandate, the CSIR performs multidisciplinary research and technological innovation in support of industrial development and the improvement of quality of life of South Africans. The nature of 'improvement' can manifest itself in different ways – by informing national strategy; collaborating with the mandated agencies to uplift service delivery; developing a new product or improving a technique to yield faster results; solutions that aid better shelter, health or clean water. In this respect, the CSIR has over many years established a track record for generating output that has real benefit to the people of this country. The achievements of the past year add further evidence to support the credibility of the CSIR's national role and reputation for relevance.

This report showcases a few examples of the outcomes of R&D projects in specific sectors. It is also a record of performance against governance responsibilities in the 2007/08 financial year.

The CSIR's organisational priorities were defined in line with its mandate and are anticipated to remain in place as long-term strategic objectives. These include building and transforming human capital; strengthening the science, engineering and technology (SET) base and performing relevant research; and transforming technology and skilled human capital to the market or society at large.

THE CSIR'S ORGANISATIONAL PRIORITIES WERE DEFINED IN LINE WITH ITS MANDATE. THESE INCLUDE BUILDING AND TRANSFORMING HUMAN CAPITAL; STRENGTHENING THE SCIENCE, ENGINEERING AND TECHNOLOGY BASE AND PERFORMING RELEVANT RESEARCH; AND TRANSFORMING TECHNOLOGY AND SKILLED HUMAN CAPITAL

Building and transforming human capital

Logically – as is the case for any knowledge organisation – the quality of intellectual assets is critical to the CSIR's performance. The competition for top skills is fierce – particularly in specialist areas or in new fields of science. Female SET professionals appear to be in short supply.
A human capital development strategy and programmes were implemented in the past year to coordinate a focus on ensuring the quality and appropriate quantities of skills in the organisation. Numbers for postdoctoral and PhD-level staff are increasing steadily and a large number of full-time postgraduate students are being supported by the CSIR – many in critical skills areas. In terms of demographics, the CSIR has broken through the 50% level of black SET staff employed.

Relevant research, real outcomes

The CSIR's contract R&D portfolio is robust across sectors and research domains. Of particular importance is a growing number of national SET strategies and policy processes to which the CSIR contributes.

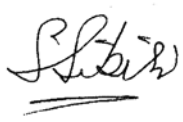
An important marker of SET output is the upward trend in publication equivalents. This number grew to 343 in the past year – an increase of approximately 64% on the year before.
The CSIR is also increasingly securing means of disseminating its research information in the public domain. One channel launched for this purpose is a web-based 'research space' content repository on the CSIR web site.

Ensuring the quality and quantity of our intellectual property (IP) portfolio is the formal adoption of an IP and technology transfer strategy, policy and associated operational model. In the past year, 35 new inventions were disclosed and 39 technology packages produced for transfer. Income from royalties and licence fees came to R9,1 million – greater than the set target and an amount that is expected to grow further over the next few years.

Operations

The CSIR's total operating income stands at R1,2 billion – a higher-than-projected achievement and one that surpasses that of previous years. Operational efficiency and quality practices remain of high standard. Formal processes and systems to support strategic procurement were implemented and contribute to a successful broad-based black economic empowerment (B-BBEE) strategy.

It would be remiss not to acknowledge that the exceptional performance of the past year is attributed to the people of the CSIR.
The organisational pride is closely tied to the CSIR's role as national authority and the opportunity to contribute to the country and its people's progress and prosperity. This is science in service, science with real impact.



CSIR Mandate

The CSIR's mandate is as stipulated in the Scientific Research Council Act (Act 46 of 1968, as amended by Act 71 of 1990), section 3: Objects of CSIR:

"The objects of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act."

Project portfolio

The CSIR's work responds to a number of national priorities. The following pages highlight some projects working towards improving or making the best of South Africa's natural resources, global change, waste management and strategies towards a clean South Africa, biotechnology, infrastructure and services, industry, information and communications technology, safety and security, and energy.

Also featured are some projects undertaken across South African borders.

Making the most of South Africa's Natural resources

Photo: RvA/EARTHSTOCK

Making the most of South Africa's Natural resources

Sustainability of natural resources enjoys global attention

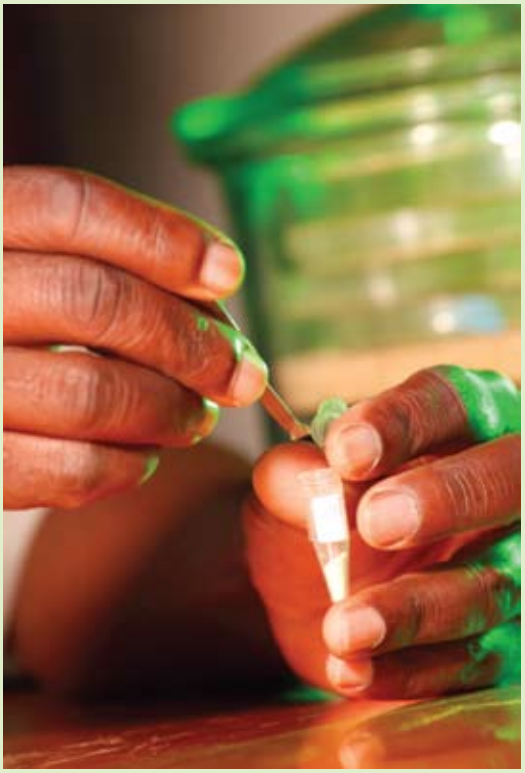
The predominant driver of environmental research internationally is the acknowledgement by most governments, including South Africa, of the urgency and importance of dealing with the threats of climate change. Principal events include the Intergovernmental Panel on Climate Change's (IPCC) finality on the climate change phenomenon being human-induced, the Stern Review, the Al Gore documentary film 'An Inconvenient Truth' and the awarding of the Nobel Prize to Al Gore and the IPCC report, to which the CSIR contributed.

Governments are making decisions on how to deal with climate change, although there is not universal recognition of the uncertainty of what will happen where. The recent United Nations Environment Programme's fourth Global Environmental Outlook: Environment for Development (GEO-4) report is the first state of the world report in 20 years. Aside from climate change, the report illustrates serious global environmental deterioration over this time, arising from population growth, increasing consumption associated with economic development and improper use of chemicals and technologies. Freshwater supplies, agricultural land and biodiversity are key concerns.

More than half of all cities now exceed World Health Organization pollution guidelines. In Africa, poverty is extreme (5% of the world's income and two-thirds of the world's debt), and this is seen as a cause and a consequence of land degradation.

In South Africa, the recently-released South Africa Environmental Outlook (state of environment report) paints a bleak picture, which is likely to stimulate a broad response in government. The average ecological footprint in South Africa is higher than the world average, and growing compared to the trend for other low to middle-income countries. The Environmental Sustainability Index for South Africa in 2005 ranked 93rd among 146 countries, and ranked 20th among the 40 NEPAD countries. All categories of indicators (other than those for agriculture and access to electricity) show a downward trend – or a lack of knowledge to provide an assessment. If South Africa is to demonstrate responsible resource management, government will need to determine its response to the assessment and decide on developmental options.

At the same time, the Human Poverty Index in South Africa has worsened from 16,4% in 1995 to 31,7% in 2002 – a growth of 1,7 million people living below $1 per day. South Africa's economic growth has not created sufficient employment, and emerging evidence shows that economic growth is starting to cool, and that low assurance of energy supply is a serious impediment to further growth. This is likely to lead to re-doubled efforts to stimulate the economy through investment in infrastructural (especially energy) and industrial development. But such development will need to be placed in the context of climate change and environmental sustainability, and these issues are likely to be subject to increasing debate.



The Department of Science and Technology has identified global change, including uncertainty around regional climate change projections, as one of the five grand challenges in the department's 10-year plan, and the grand challenge on energy security also relates to climate change.

Environmental assessment will need to adapt to changing understanding and the realities of the South African environment to shake off the 'green handbrake' image. Alternative energy sources will need serious consideration to support sustainable development.

The Industrial Policy Action Plan (IPAP) and Biofuels Draft Strategy promote the development of a biofuels industry, but careful choices will need to be made. Issues of pollution and waste will need to be addressed meaningfully to respond to the very real human health consequences of pollution, and to ensure that South Africa does not destroy its natural capital and further diminish the resources available to support development. South Africa needs to improve the benefit flows of natural resources to the growing number of impoverished and vulnerable people through sound ecosystem management. Recognition of environmental goods and services by the Department of Trade and Industry should formalise the recognition of the role of ecosystems in the economy.

The mining industry, in particular, is facing critical challenges. Mining remains a vital component of the economy for the foreseeable future and needs to overcome the ever-increasing difficulty of mining the available resources. Despite this, no national view exists on an approach to mining research, and industry support for research has declined to trivial levels over the past 15 years. The health and safety record of the industry is increasingly under scrutiny, and it appears that the trend of improvement in this regard has stopped. Recent events have led to Presidential insistence on an audit of the industry. Mining also has substantial environmental impacts in terms of pollution, waste and water resources, and the industry needs much research in support of safety and environmental issues to ensure it justifies its 'social licence' to operate.

The forestry, timber, pulp and paper industry is another significant resource-based industry in South Africa, and is also inextricably linked to environmental issues, principally land and water use, and pollution and waste associated with primary processing. The key challenge is to improve the socio-economic benefits derived from tree production, while ameliorating the negative consequences. The National Industrial Policy Framework and IPAP identify this as one of four lead sectors and call for increased small-grower afforestation in KwaZulu-Natal and the Eastern Cape, as well as greater processing capacity in these regions. The recently-completed forestry science, technology and innovation plan addresses the technical requirements for deriving more value from fibre, and this should provide the research framework in support of the development of the forestry, timber, pulp and paper industry.

Making the most of South Africa's Natural resources

INCREASED SAFETY IN MINING NATURAL RESOURCES

Ropes, dust and self-rescuing

The mining industry is South Africa's biggest employer, with around 460 000 employees and another 400 000 employed by the suppliers of goods and services to the industry. The safety of mine workers is paramount and the CSIR works closely with industry stakeholders to create a safer work environment.

One way in which the CSIR contributes to this objective is the destructive tensile testing of mine hoist ropes used to transport thousands of workers up and down mine shafts each day. The CSIR is the recognised custodian of in-service mine rope technology and performs the bulk of these statutory tests.

At a test facility near Pretoria, the CSIR presents mine workers with a dramatic reminder of the dangers of methane and coal dust explosions. This facility is also used to evaluate explosion suppression systems; the flammability of conveyor belts; the effectiveness of dust suppression systems; and similar investigations.

In a third endeavour to improve mine safety, some 160 000 self-rescuers are deployed in underground mines in South Africa. In an emergency, escape depends on the reliability of the self-rescuer, and the CSIR's performance monitoring programme helps ensure that self-rescuers function properly.

Seismicity

Platinum mines, such as those found in the Bushveld Complex (BC), use in-stope crush and yield pillars that occasionally fail violently. This seems to happen more often at certain mines where leave pillars are arguably too large.

A yield pillar is one that deforms beyond its full strength as it emerges from the face whereas a crush pillar is designed to fail soon after it emerges from the face when the loading system is still sufficiently stiff to reduce the possibility of bursting.

Mining layouts and methods are dictated principally by the depth and geometry of the ore body and the degree of geological disturbance. While the level of seismicity in the BC platinum mines is relatively low, pillars nevertheless fail suddenly and generate seismic events.

CSIR researchers found that rockbursts pose less of a problem on the BC than on deep-level gold mines. Research also found that very few in-stope pillars in BC mines actually crush on the face in response to blasting. The majority yield or crush towards the back areas. Occasionally a pillar may burst violently, though little damage is generally caused to the surrounding area.

THE CSIR IS THE RECOGNISED CUSTODIAN OF IN-SERVICE MINE ROPE TECHNOLOGY AND PERFORMS THE BULK OF THESE STATUTORY TESTS

Smarter, safer

Underground mines in South Africa are typically monitored using manual methods. A number of reasons exist for this, including the lack of robust low-cost sensing and communication systems available for use underground. AziSA is a standard and a reference implementation being developed at the CSIR to enable the low-cost acquisition of data in the working place, and the communication of that data to the nearest permanent IT infrastructure, and then onto intelligent database systems for later query.

As an open standard, AziSA can be applied wherever data are required, but is optimised for disposable very low-power wireless sensors.

The standard is currently being implemented in a system to monitor rockfalls in a number of mines as part of a major R10 million project for the Mine Health and Safety Council.

The vision for AziSA is that it will enable ubiquitous sensing underground, and thereby make mines smarter, safer, healthier and more productive.

CSIR LEADS IN DEVELOPING COMPOSITE COMPONENT MATERIALS

The CSIR is leading a consortium to develop natural fibre-reinforced composites for potential use in the interiors of aircraft.

FAST FACT

Indigenous goat breeds may hold the key to cultivate prosperity in previously disadvantaged rural communities. A research study by the CSIR has found that the coat of the humble goat has the potential to create and contribute to a viable cashmere industry in South Africa.

The indigenous goat population of some 6 million is kept mainly for its meat, milk and skin products, as well as for controlling bush encroachment. Potential exists for further value-addition by utilising the fine, soft undercoat (cashmere) present in some of the breeds to produce luxury garments.

The project, to be executed in two phases of 18 months each, will be for the duration of three years that started in October 2007. The project was awarded by the Department of Science and Technology's Advanced Manufacturing Technology Strategy to the CSIR in partnership with Airbus.

Natural fibre composites are regarded as a substitute for traditional materials and may hold the key to successfully addressing some of the major challenges faced by the automotive and aerospace industries.

The CSIR's fibres and textiles research area in Port Elizabeth has invested in a state-of-the-art nonwoven pilot plant, which is one of the top four such facilities in the world. Researchers are involved in developing a natural fibre composite material in conjunction with several academic institutions and industry partners.

Research currently centres on the development of natural fibre composites for use in the non-structural components of the aircraft cabin, as well as on the use of these fibres in the automotive industry. The impact energy absorption and failure mechanisms of woven natural fibre-reinforced polypropylene composites and their hybrids are investigated.

Research is conducted on chemical modification of natural fibres like flax, hemp and sisal by using suitable compatibilisers and biological coupling agents. Attention is paid to the influence of processing conditions on the physical and chemical characteristics of natural fibres, fabrication of composites from needle-punched nonwovens (flax and kenaf) and thermoplastics by compression moulding, along with the characterisation of green composites.

CSIR TO DETECT MOHAIR SHEEN

The South African and international mohair industry may soon benefit from a novel project of the CSIR to develop a device to measure the lustre of this elite fibre.

South Africa currently produces more than 60% of the world's mohair. The silk-like natural fibres are from the hair of the Angora goat and can be woven or spun into plush fabric.

Lustre, one of the most important characteristics of mohair, distinguishes it from all other animal fibres of similar fineness. One of the quality attributes associated with South African mohair is its excellent lustre properties. The lustre that differentiates mohair is largely due to its relatively smooth surface, resulting from its relatively thin and long scales.

The CSIR has been conducting collaborative and innovative research to enhance the competitive capabilities of the South African textile and clothing industries.

Current research on mohair concentrates on measuring the surface characteristics (surface roughness, scale definition and density) of the mohair fibres and relating these measurement values to lustre. If these results prove promising, an instrument – probably based on high-resolution image analyses for rapidly measuring surface characteristics, possibly at the same time as diameter – could be developed.

THE CSIR AND THE UNITED NATIONS INDUSTRIAL ORGANIZATION ARE INVESTIGATING THE FEASIBILITY OF DEVELOPING A WILD SILK INDUSTRY IN SOUTHERN AFRICA

INDIGENOUS MOTH HELPS ENSURE A FUTURE THROUGH SCIENCE

The CSIR embarked on a research project that benefits disadvantaged communities and optimises the use of the lowly silk moth, habitant of mopane and camel thorn trees that abound in southern Africa.

The African wild silk moth *(Gonometa postica)* is a species that is of particular economic interest. It has been shown that the silk fibres obtained from the cocoons of *G. postica* are of exceptional quality, comparable to that of the domesticated silk moth, *Bombyx mori*. This holds promise as a potential income-generating resource for the indigenous people of southern Africa, while simultaneously not harming or endangering the environment.

At the CSIR offices in Port Elizabeth, natural fibres such as wild silk are being used to create new fabrics with excellent properties, while having a lesser impact on the environment than some conventional fabrics.

AGAVE INDUSTRY FOR SOUTH AFRICA SECURED

THE RESULTS OF THIS RESEARCH HELPED DEVELOP A GENERAL CONCEPT FOR COMMERCIALISING THE *A. AMERICANA* IN THE RURAL AREAS OF THE GREAT KAROO

The CSIR is contributing to the establishment of an agave industry in South Africa. This industry promises to transform the rural economy and create jobs for subsistence farmers and entrepreneurs in the Great Karoo and Lesotho. External partners in the project are the Department of Trade and Industry, the Eastern Cape Development Corporation, Cacadu district municipality, textile and paper-manufacturing companies in South Africa, and international stakeholders in Brazil, Lesotho and Swaziland.

A recent presentation of the *Agave americana* project to the UN Inter-governmental Group on Hard Fibres has created the opportunity to secure a lucrative contract of R16 million with the Common Fund for Commodities.

A. americana is commonly associated with liquor beverages, similar to tequila. Following a CSIR research study, it will soon be a coveted source of raw material for items ranging from paper-making, composites for the automotive industry to the pharmaceutical and food industries. Research found that all parts of *A. americana* can be utilised successfully for various applications. The 'zero-waste' utilisation of the plant would enable its production and processing to be translated into a viable and sustainable agave industry.

The results of this research helped develop a general concept for commercialising the *A. americana* in the rural areas of the Great Karoo.

SAP OF ILALA PALM DESTINED FOR NICHE MARKETS

Ubusulu, a beverage made from the sap of the Ilala palm tree, is traditionally brewed by the Zulu people. Using the ancient method as a foundation, a CSIR team of food and bioprocessing scientists has developed new and innovative processes for the competitive production of Ilala palm wine and a host of fruit pulp-based products and indigenous alcoholic beverages originating from the lush surroundings of the impoverished Manguzi (Maputaland) region. These products are destined for speciality niche markets.

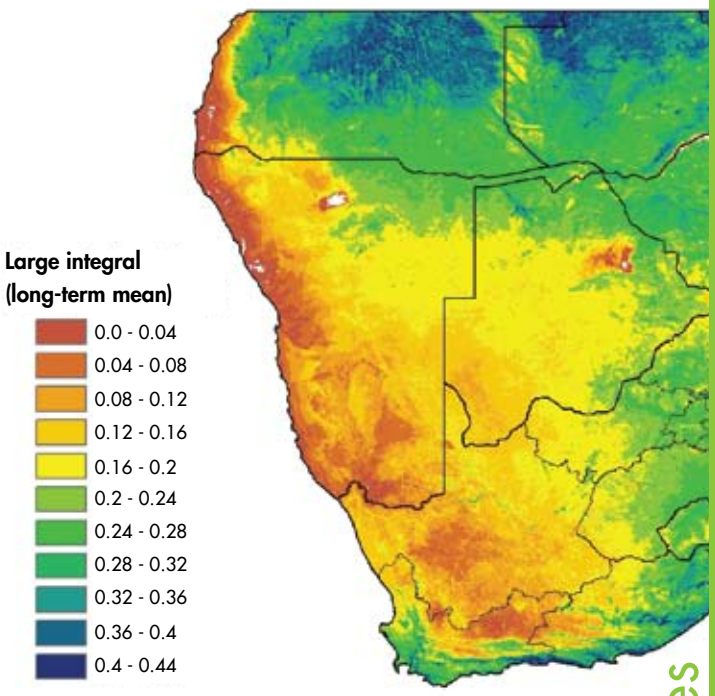
CSIR scientists have designed, installed and commissioned a fully-functional pilot plant, equipped with oven driers, state-of-the-art fermentors, a fruit-processing machine, a fruit-pulp pasteuriser and a juice processor in Manguzi, operated exclusively by members of the community.

In 2008 the prototypes of Ilala palm cooler were completed, resulting in a safer end product compared to the classical, uncontrolled fermentation process. The beverage will be marketed in 340 ml and 750 ml versions. Further expansion of the pilot-scale technology will result in job creation and improved quality of life not only in South Africa, but also on the continent. This work is done in partnership with the Maputaland Development and Information Centre, the Department of Science and Technology and the Kellogg Foundation.

MODELLING VEGETATION PHENOLOGY USING 20 YEARS OF DAILY SATELLITE DATA

Vegetation phenology examines life cycle events such as bud burst, flowering and leaf senescence. As the phenology of terrestrial ecosystems reflects the response of the biosphere to climatic factors such as temperature and rainfall, it can be used to identify vegetation types and monitor vegetation responses to changes in climatic determinants. Field data on leaf phenology are difficult to obtain, labour intensive and give limited information. Time-series of coarse resolution satellite data contains indispensable information on seasonal vegetation dynamics at regional to global scales.

CSIR researchers have used close to 20 years of daily 1 km AVHRR satellite imagery to model vegetation phenology, allowing unique analyses of patterns across the entire southern Africa. Ten-daily, near cloud-free composite images for the entire time series were used to fit the phenological curves for each image pixel through time.



Insightful maps have been produced for southern Africa, showing patterns that would otherwise have been impossible to observe. This required robust modelling to overcome the constraints of 'noisy' time series of satellite vegetation index data.

PLANT PROJECTS SERVED BY TELEMETRIC WEATHER STATIONS

In partnership with an expert contractor, the CSIR has implemented an improved system for the remote gathering of climate data on selected essential oils and medicinal plant project sites. The system consists of a weather station and internet-based virtual private network communication technology.

Nine weather stations were installed on sites that represent diverse climatic conditions throughout the country.

In addition, soil moisture meters were coupled to the weather station and data from these instruments are transmitted via the same telecommunication system.

Data were collected continuously on all the installed stations and it was found that both the hardware and the communication systems are highly reliable. The availability of such data will allow retrospective analysis, after a two to three-year period, of factors that may influence the quality and quantity of the plant-derived products. This information will then allow the development of guidelines related to site selection on a basis of prevailing climatic conditions and guide irrigation protocols.

In the Kalahari, data are shared with researchers that study the effect of global warming on the survival of medicinal plants of the Khomani San.

TABLE MOUNTAIN GROUNDWATER EXTRACTION COULD HAVE ECOLOGICAL IMPACTS

The Cape's Table Mountain Group (TMG) aquifer has been eyed as a potential source of water for some time, and the City of Cape Town has started a feasibility study to see whether this aquifer can deliver 80 million m^3 as claimed. The CSIR led the project, funded by the Water Research Commission, characterising the role this aquifer plays in the natural environment.

The project has shown that the ecological role of the aquifer is critical in terms of maintaining hydrological heterogeneity – or 'hydrodiversity' – in the fynbos, with both terrestrial and wetland plants accessing groundwater from saturated sources.

Research demonstrated which tools can be used successfully to trace groundwater flows and monitor impacts on the environment. The TMG has a high radon signature, and this tracer can be used along with temperature and dissolved silica to establish where the aquifer is discharging into wetlands, rivers and the sea.

The project has proven the feasibility of establishing monitoring boreholes in remote mountain areas without damaging the natural environment. The methods pioneered by the CSIR and its partners will be used by the City of Cape Town and the Department of Water Affairs and Forestry to ensure that future large-scale TMG groundwater abstraction is managed sustainably.

IMPROVED DISTILLATION FACILITY DEVELOPED

The financial sustainability of some of the essential oils ventures established by the CSIR has come under increasing pressure due to the rising cost of fuel and low oil yields.

Together with technology partner Herbs Aplenty, the CSIR has developed a new, improved distillation facility to address these problems. The new facility was designed and installed at Genadenberg Natural Products, a community-based venture. The first distillations have shown a 63% increase in yield for buchu and a significant decrease in fuel consumption. These results have positive implications for the financial sustainability of the current portfolio of essential projects being implemented by the CSIR.

The new system does not use a cooling tower, resulting in a saving of about 20% in water consumption. In water-stressed areas, this environmental issue is of particular importance.

THE FIRST DISTILLATIONS HAVE SHOWN A 63% INCREASE IN YIELD FOR BUCHU, A SIGNIFICANT DECREASE IN FUEL CONSUMPTION AND A SAVING OF ABOUT 20% IN WATER CONSUMPTION

CSIR contributes extensively to global water bodies

The CSIR's engagement with the World Water Council (WWC) started shortly after 1994. The WWC has special consultative status with, among others, the United Nations Educational Scientific and Cultural Organization (UNESCO).

Over time, the CSIR has become engaged with the WWC to the extent that the CSIR is now well-established on the Board of Governors. During the past financial year, two CSIR experts were elected as Governor and Deputy-Governor, respectively, of the Board of the council. Both now serve on the Program Committee, determining the content of the next World Water Forum in Istanbul in 2009.

The CSIR is also a highly regarded participant in the International Water Resources Association (IRWA), one of nine founding members of the WWC and a force in its formation as an organisation committed to global water policy. On account of the CSIR's proactive engagement with IRWA, the management of the association has been relocated to South Africa. The local Water Institute of South Africa (WISA) is the host organisation, with one of the CSIR's experts as an executive director and editor of the official IRWA journal.

THE CSIR IS NOW WELL-ESTABLISHED ON THE BOARD OF GOVERNORS OF THE WORLD WATER COUNCIL

CSIR contributes towards AfricaArray's success

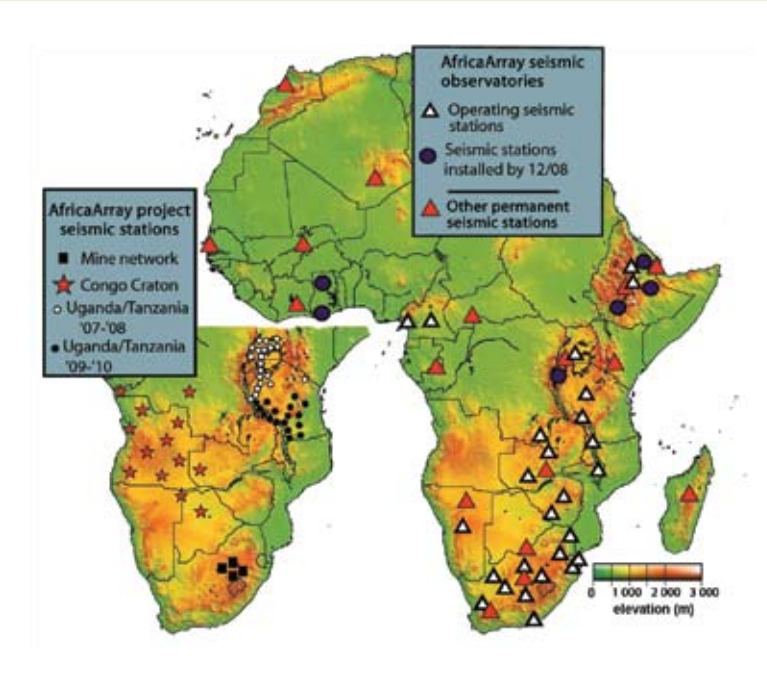
AfricaArray is a 20-year initiative that seeks to meet NEPAD's requirements for continent-wide cooperation in human resources development. Founded by the University of the Witwatersrand, Pennsylvania State University and the Council for Geoscience in 2004, AfricaArray seeks to train high-level geoscientists to support Africa's natural resources sector.

The partner network now includes 14 universities, 19 government institutions and 14 companies in Africa, as well as many organisations outside of Africa.

A CSIR seismology expert leads the teaching and research effort in Africa. During the past year, CSIR scientists provided classroom and field instruction to numerous students and supervised 14 postgraduate research projects. Two AfricaArray students are sponsored by the CSIR.

The CSIR plays a leading role and often participates in global seismology gathering, but is also actively involved in regional research and development, such as the recent installation of a seismic station in Botswana.

Seismic waves from global earthquakes are used to image the features in the earth's interior, such as the 'African Superplume', the largest seismic anomaly in the mantle. The permanent AfricaArray seismic network consists of 26 broadband stations in 11 countries.



CSIR to implement SA's earth observation framework

The Group on Earth Observation's (GEO) Global Earth Observation System of Systems (GEOSS) has a 10-year implementation plan to establish a comprehensive, global monitoring system for end users to access a vast quantity of near-real-time information on changes in the earth's land, oceans, atmosphere and biosphere via a single web portal. In response to this, the South African Earth Observation Strategy (SAEOS) shapes plans for earth observation infrastructure.

Implementation of SAEOS has been delegated to the CSIR by the Department of Science and Technology. The first phase is at the CSIR earth observation data centre (EODC) at Hartebeesthoek. Its architecture comprises both state-of-the-art hardware and software for significant storage capacity and fast data extraction for image processing.

The EODC produces fully-automated remote sensing supply chains using an automated processing system called South African Resource Management and Expert System (SARMES). This allows the creation of fully automated processing chains to automate all steps from raw data ingestion to the packaging of a final orthorectified mosaic in a user-defined format.

An environmentally-conscious South Africa: Global change

An environmentally-conscious South Africa:

Global change

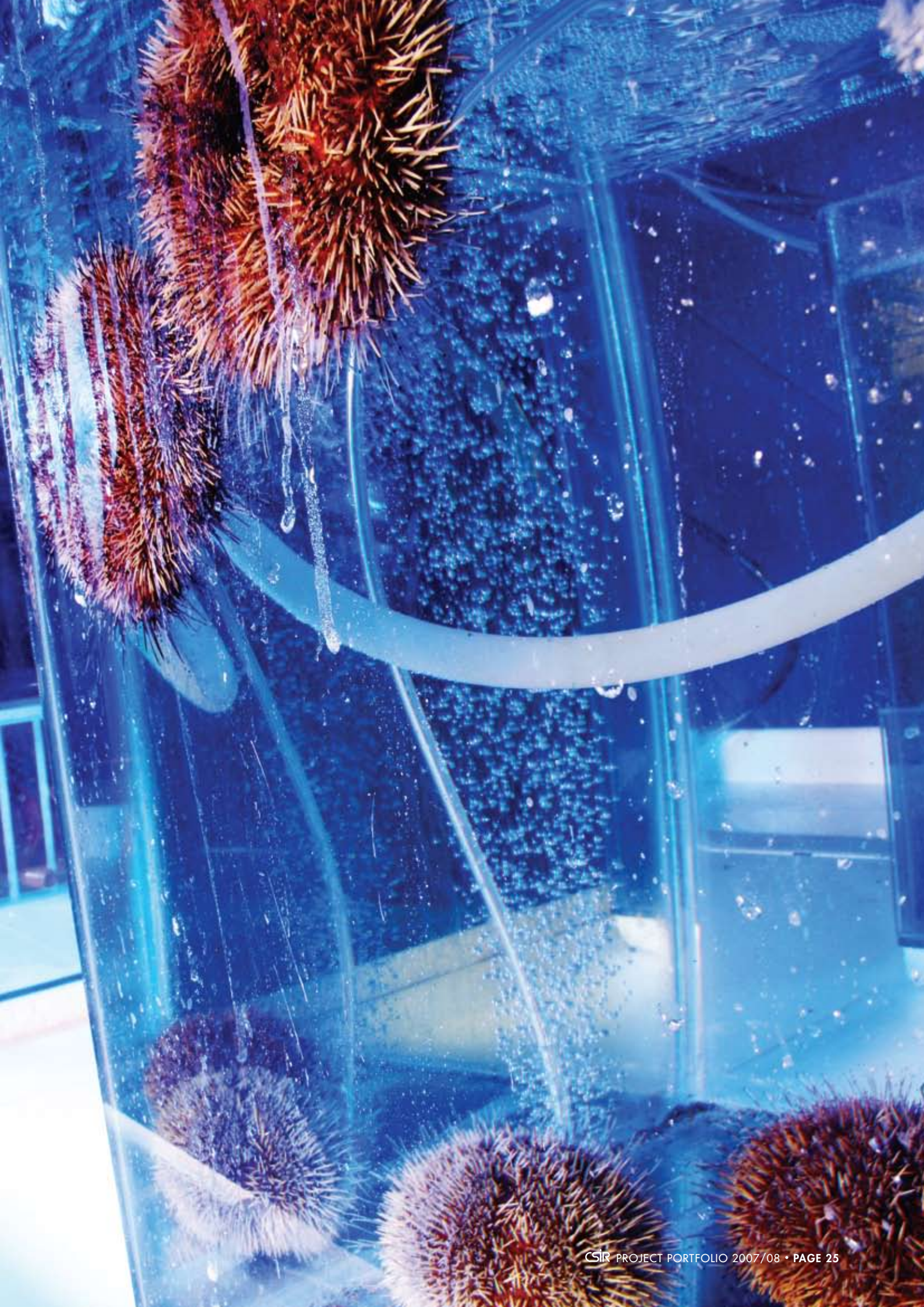
Successfully mitigating global change

We live in a time of unprecedented change. Across the planet, humans have transformed the surface of the land to make space for cities, crops and plantations. They have significantly altered the composition of the atmosphere through the consumption of fossil fuels and the large-scale alteration of biogeochemical cycles. They have exploited the living resources of the oceans to levels of collapse. Huge increases in global trade and travel have resulted in the re-distribution of species to support agriculture, forestry and mariculture; many of these become aggressively invasive, with significant negative consequences.

The net outcome of these changes constitutes a syndrome known as global change, which includes changes to circulation in the oceans, land degradation, melting ice-sheets and accompanied rises in sea level, and changes in climate. Never before has science been called on to address such ubiquitous and significant challenges.

Developing countries like South Africa have to formulate appropriate responses to these changing conditions, based on the best available science and research. These responses are usually divided into two types: mitigation, which seeks to find ways of reducing the primary drivers of change (such as dependence on fossil fuels); and adaptation, which recognises that change is inevitable, and that to reduce its impact, we need to change the way we do things.

To address these issues, responses that are appropriate to the unique South African conditions need to be developed. This would involve the ongoing adjustment of emerging understanding at a global level to local conditions, as well as making contributions to the improvement of global understanding by contributing local perspectives. The CSIR has drawn on its wealth of expertise in ecology, modelling, engineering, oceanography and remote sensing to address issues in both the natural and built environments.



An environmentally-conscious South Africa: Global change

ACCESS TO GLOBAL CHANGE INFORMATION

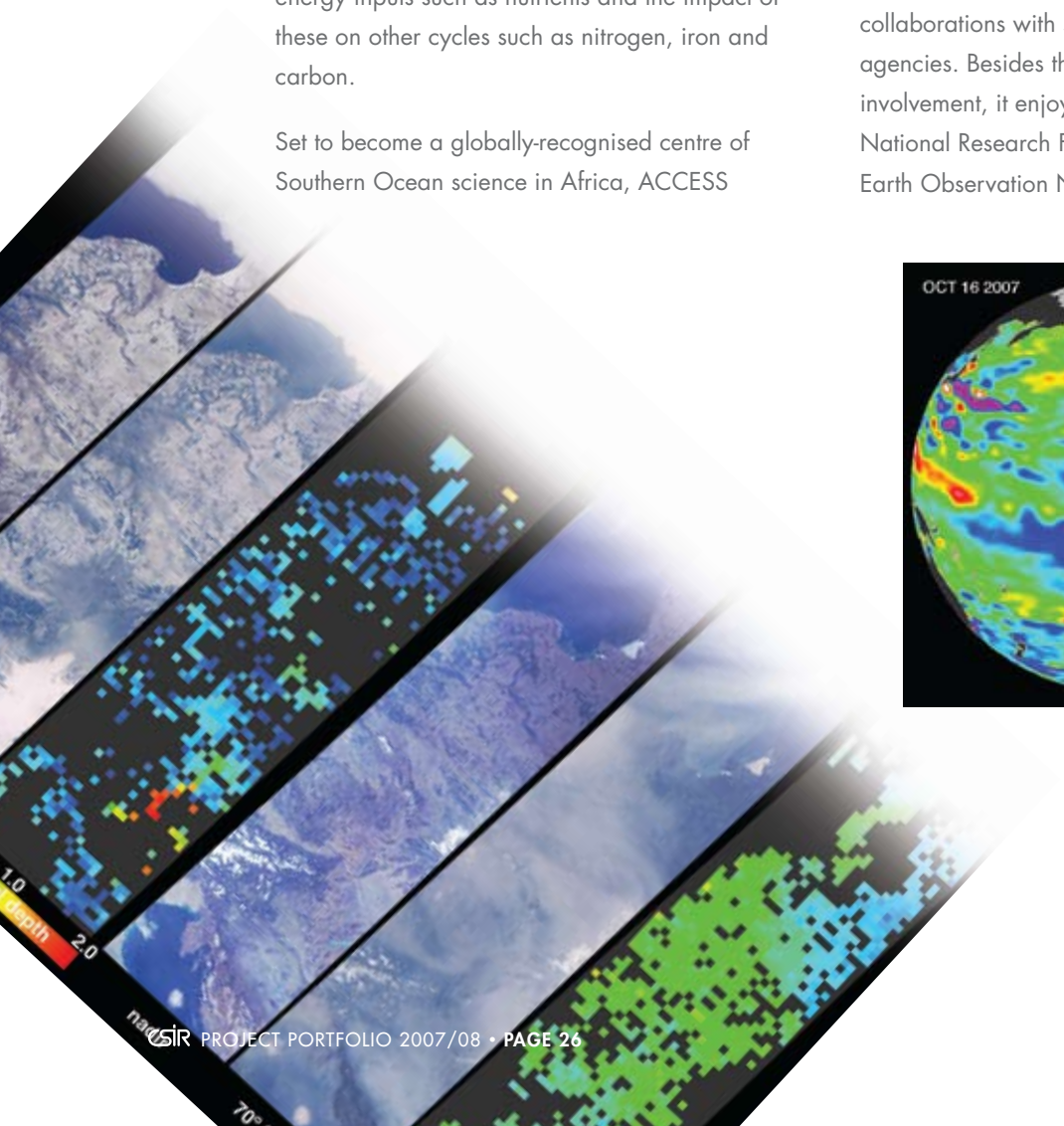
In 2007, a four-year multiproject international initiative – the Southern Ocean CO_2 Observatory Programme – was initiated to establish a CSIR climate-centred oceanographic research and development capability. This will make a significant contribution to ACCESS (Africa Centre for Climate and Earth System Science) and the Department of Science and Technology's (DST's) long-term climate research and education plans.

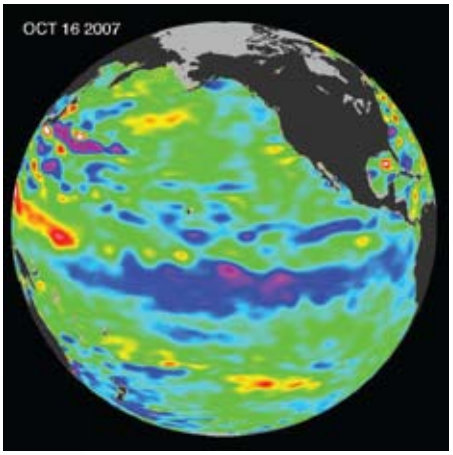
The Southern Ocean is poorly studied despite the fact that it is one of the most productive regions of the world. The biogeochemistry of the Southern Ocean considers the relationship between the energy inputs such as nutrients and the impact of these on other cycles such as nitrogen, iron and carbon.

Set to become a globally-recognised centre of Southern Ocean science in Africa, ACCESS is an interinstitutional initiative to stimulate an understanding of climate through a coupled systems approach (e.g. coupled ocean-atmosphere) supported by advanced high-speed computing facilities and providing a new space within which a new generation of South African scientists can develop.

Among other interventions, monitoring and observation programmes form an essential part in acquiring the data necessary for comprehensive situation analysis and ultimately, long-term predictable climatic behaviour.

To achieve its goals, ACCESS depends on collaborations with scientific institutions and agencies. Besides the DST and the CSIR's involvement, it enjoys high-level support from the National Research Foundation and the South African Earth Observation Network, to name but a few.





LAND DEGRADATION IN THE KAROO RESEARCHED

The Little Karoo is a semi-arid region with a unique biological and physical character and is rich in biodiversity, with more than 1 325 plant species, 182 of which are found nowhere else in the world.

The deeply-rooted practice of ostrich farming in this region has had an extremely destructive effect on the region's ecosystems. Breeding flocks range feely, trampling a myriad pathways across the veld, not only crushing much of this irreplaceable plant biodiversity, but affecting the soil surface, compacting it, and forever changing its potential.

Studies undertaken by the CSIR during the past three years have sought to develop an understanding of the socio-ecological resilience of the region, the financial viability of returning natural capital back to its original state, the state of water resources, and trade-off in ecosystem services.

The Little Karoo study area can be seen as a microcosm of what is going on in greater South Africa, now and into the future, given climate change and the predicted reduction in rainfall, increasing water scarcity, and worsening agricultural conditions.

THE DEEPLY-ROOTED PRACTICE OF OSTRICH FARMING IN THIS REGION HAS HAD AN EXTREMELY DESTRUCTIVE EFFECT ON THE REGION'S ECOSYSTEMS

BIOLOGICAL CONTROL IS OFTEN THE ONLY LONG-TERM SUSTAINABLE OPTION

RESEARCH ON BIOLOGICAL CONTROL OF INVASIVE SPECIES

The effective management of alien plant invasions is often a combination of various control options, including mechanical, chemical and biological control, and ecosystem rehabilitation.

While mechanical and chemical control can be effective weapons against plant infestations, they are at best holding actions, as the invasive species are never eradicated and will resume invading as soon as the control effort stops.

Biological control is often the only long-term sustainable option. It entails the deliberate introduction of specific insects, mites or pathogens to attack the target plant. Exhaustive safety testing is executed before a biological control agent is released, but it remains controversial despite an impeccable safety record. Biological control is a safe, cheap and sustainable option. The CSIR has been involved in estimating the costs and benefits of biological control as part of its contribution to finding sustainable solutions to the problem of invasive species.

UNDERSTANDING NATURE THROUGH IMAGING SPECTROSCOPY

Imaging spectroscopy or hyperspectral imagery is helping CSIR scientists study the impact that nature and our own actions have on the world.

A hyperspectral image is produced by a spectral imaging sensor that is mounted on a distant platform, such as a satellite or aircraft. It uses hundreds of very narrow, contiguous wavelength bands to detect reflected energy that appears in the form of 'spectral fingerprints' across the light spectrum.

FAST FACT
Hyperspectral data help the CSIR to advise authorities on the nature and causes of changes to the ecosystem and strategic solutions that can reduce destructive impacts on our living environment.

The technology is used for a variety of purposes: to identify plant species, map vegetation, characterise soil properties, identify contamination, classify habitat characteristics and differentiate causes of vegetation stress.

Vegetation changes are generally attributable to natural variations, climate and global influences, or the result of human impact. Plant conditions are assessed by their spectral signature, which implies that electromagnetic spectra reflected from vegetation can differ distinctly from each other based on the condition of the vegetation, much like individuals' signatures differ. Through hyperspectral data, researchers are able to detect plant stress, heavy-metal uptake, nutrient deficiencies, insect damage and water quality.

VULNERABILITY TOOLBOX TO HELP ELIMINATE ENVIRONMENTAL POLLUTION

CSIR environmental health researchers have been conducting a project to understand and address the vulnerability of communities to air pollution. The aim was to develop a vulnerability-interventions approach that uses appropriate means to inform decision-making in local government. A vulnerability framework, defining vulnerability as having three components – susceptibility, exposure and coping capacity – has been guiding this research.

As part of the project, a survey of 377 households was conducted and the data collected are being analysed. The goal of the survey was to identify possible associations between vulnerability factors and two broad environmental health outcomes, namely respiratory and waterborne diseases.

The challenge is to identify what is needed to reduce vulnerability of low-income communities to air pollution, thereby improving their quality of life. This requires a multisectoral and multidisciplinary process. Recent research, combined with the CSIR's current work to optimise interaction between different sectors such as local government, the community and others, will assist with the appropriate decisions.

CSIR LEADS ASSESSMENT OF ELEPHANT MANAGEMENT

The Minister of Environmental Affairs and Tourism appointed the CSIR to lead an assessment of scientific issues relevant to managing southern Africa's rapidly growing elephant population. In addition to the 60 expert authors of the assessment, including biologists, economists, philosophers, animal rights activists and lawyers, rigorous and open review formed an important element of the subsequent report *The 2007 South African Assessment of Elephant Management.*

Scientific assessments are useful when the underlying evidence is technically complex and somewhat disputed. Assessments do not prescribe policy. They provide the information on which informed decisions can be made by government authorities, park managers and elephant owners, as well as revealing the areas where more research is needed.

Approaches to elephant management include expanding or limiting their range, moving them between protected areas, contraception and culling. Research on each of these aspects was included in the document, along with evaluations of the effect of elephants on people and biodiversity, and the legal, ethical and economic issues involved. The report will be published as a book towards the end of 2008.

FIRE MANAGEMENT AIMS TO MINIMISE RISKS

The CSIR is involved in several initiatives that seek to understand how, why and when severe bushfires will occur, and to develop appropriate responses to enhance the beneficial effects as well as to reduce the negative impacts of these fires.

The nature of fires is determined by conditions of weather, fuel and the availability of sources of ignition. Fires are necessary for the maintenance of healthy ecosystems but they can also damage crops and property.

A CSIR team comprising fire ecologists and statisticians is conducting the most detailed analysis of past fires ever done in South Africa. The findings will shed new light on appropriate responses in terms of managing and responding to the risk of fires.

In addition, the CSIR has developed an active fire alert system in partnership with Eskom, the University of Maryland and NASA, and with funding from the Department of Agriculture. Known as the advanced fire information system (AFIS), it is used to pinpoint fires in near-real time over southern Africa. It is also a world-first for coupling remote sensing with cell phone technology for alert messaging, or SMSs.

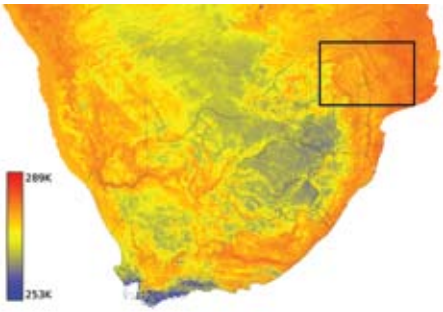
OPTIMISING CONSTRAINTS OF A DIURNAL TEMPERATURE CYCLE MODEL

Tracking active fires in southern Africa in near-real time can be done using satellite data from the Meteosat Second Generation (MSG) satellite, which transmits a snapshot of the observed brightness temperature over Africa and Europe at 15-minute intervals. It is also possible to detect fires by looking for sudden changes in temperature through time, rather than space; this requires a model of the temperature changes throughout the day, known as the diurnal temperature cycle (DTC).

Remote sensing researchers at the Meraka Institute have been developing a parametric model that describes the DTC with a high degree of accuracy. Model parameters that minimise the discrepancy between observed temperatures and model predictions are determined using robust numerical optimisation algorithms.

Unwanted variations in the model predictions are controlled by applying constraints derived from Monte Carlo simulations, resulting in parameters that reflect the true surface properties more accurately.

The fitted DTC model can provide missing values caused by transmission errors or cloud cover. It is also used to drive a temperature tracking algorithm to detect smaller fires.



TRACKING ACTIVE FIRES IN SOUTHERN AFRICA IN NEAR-REAL TIME CAN BE DONE USING SATELLITE DATA FROM THE METEOSAT SECOND GENERATION SATELLITE

FREE EARTH OBSERVATION DATA FOR AFRICA

Broadening earth observation data access and capacity to end users in developing countries is vital to ensuring successful exploitation of earth observation data worldwide.

FAST FACT
The CSIR Satellite Applications Centre forms part of the CEOS troika for three years, together with outgoing chair US Geological Survey and incoming chair, Thailand's Geo-Informatics and Space Technology Development Agency.

As chair of the Committee on Earth Observation Satellites (CEOS), the CSIR Satellite Applications Centre has committed to data democracy. In practice, this means delivering remote sensing data from the China-Brazil Earth Resources Satellite (CBERS) programme at no cost to African countries 5° south of the equator.

Dubbed the CSIR's 'special project', this will mean that free country coverage is disseminated to all the African countries that fall within its footprint. These include Angola, Botswana, the Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

The CSIR is also exploring replicating this model with space agencies from other countries such as CONAE in Argentina, ISRO in India, CSA in Canada and ESA in Europe. CBERS will be the pilot to demonstrate a model to realise the special project.

Delegates at the hand-over of the CEOS Chair to the CSIR.

A MOBILE LIDAR SYSTEM IS BEING DESIGNED AND DEVELOPED AT THE CSIR. ALTHOUGH LIDAR HAS BEEN EXPLOITED FOR ATMOSPHERIC MEASUREMENTS IN MANY COUNTRIES, LIDARS ON THE AFRICAN CONTINENT ARE LIMITED TO TWO

LIDAR TO IMPROVE UNDERSTANDING OF THE ATMOSPHERE

The laser radar, more popularly known as lidar (light detection and ranging), is becoming one of the most powerful techniques for active remote sensing of the earth's atmosphere. This system is primarily designed for atmospheric studies, such as the monitoring of various pollutants in the lower atmosphere that contribute to global climate change and global warming. A mobile lidar system is being designed and developed at the CSIR.

Although lidar has been exploited for atmospheric measurements in many countries, lidars on the African continent are limited to two.

The initial results conclude that the system is capable of providing aerosol/cloud backscatter measurements for the height region from ground to 20 km with a 10 m vertical height resolution. The measurements will elucidate the aerosol concentration, optical depth, cloud position, thickness and other general properties of the cloud.

Future plans include qualitative industrial pollutant measurements, 3D measurements using an XY scanner, a two-channel lidar system, water-vapour measurements, the implementation of differential absorption lidar (DIAL) and ozone measurements.

SECOND SATELLITE MOSAIC OF SA DEVELOPED

Earth observation is a useful tool for decision-making on matters of national importance, ranging from food security and disaster management to mine rehabilitation. As South Africa does not have its own earth observation satellite, the challenge is to access satellite imagery optimally and make it available widely, to the benefit of the country.

The CSIR has a long-standing relationship with Spot Image and developed and negotiated an open access model in 2006. This model ensures access to data from the SPOT 2, 4 and 5 sensors at no cost for government departments, research institutions and academia within South Africa.

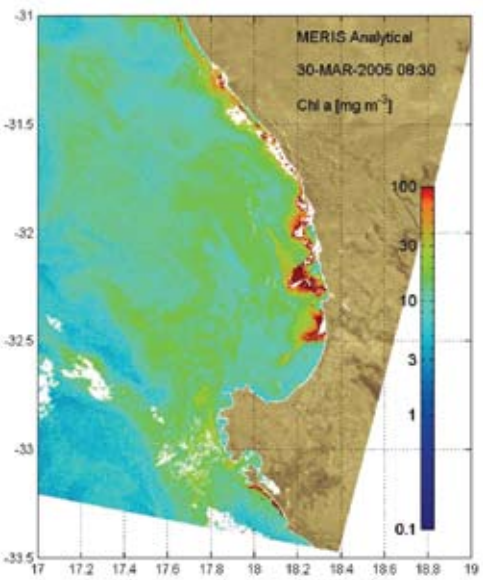
The second national 2,5 m resolution Spot 5 colour mosaic of South Africa's land surface, comprising some 1 500 Spot 5 images acquired between 1 April 2007 and 31 March 2008, has been made available to users. The higher-resolution imagery of Spot 5 allows for land-cover and land-use to be more precisely classified to aid decision-makers. As the mosaic is provided in blocks or tiles (50 x 50 km sq), it is possible for users to upload a specific geographic area of interest.

CSIR PARTNERS IN MULTI-INSTITUTIONAL MARINE REMOTE SENSING RESEARCH

Over 40% of Africa's population derive its livelihood from coastal and marine ecosystems, and this reliance is set to increase substantially. Understanding the dynamics of coastal and shelf seas is essential for managing vulnerable coastal ecosystems, protecting lives and livelihoods, and planning sustainable development.

A wide variety of ocean characteristics can be observed from space, including phytoplankton biomass and light penetration from ocean colour; sea surface temperature from thermal and microwave sensors; and winds, currents, waves and oil slicks from altimetry or synthetic aperture radar. Marine remote sensing thus offers a powerful and cost-effective means of providing information on important issues such as climate change, resource and coastal zone management, and ecosystem monitoring.

The CSIR is one of the principal partners in the multi-institutional marine remote sensing unit, which currently provides free marine satellite products to southern Africa. It is leading development in expanding these services and educating users in the uses of marine remote sensing. Examples of applications include the use of ocean colour to detect harmful algal blooms and sediment dynamics, and the use of synthetic aperture radar to monitor the Agulhas Current.



MONITORING AIR QUALITY EFFECTIVELY

To understand the potential impacts of air pollution on the environment – especially in poor communities – one has to measure the concentrations of pollutants with effective monitoring techniques. CSIR research projects therefore focus on the development of novel sampling and analytical techniques, which are more cost effective than existing methods.

A passive sampler for sulphur dioxide, developed by the CSIR, is now implemented in a number of ongoing sampling campaigns. Passive sampling has cost benefits over active sampling methods and does not require electricity, as sampling of air is based on diffusion, thus pumps are not required. Samples are taken near industrial operations and in nearby communities.

SAMPLES ARE TAKEN NEAR INDUSTRIAL OPERATIONS AND IN NEARBY COMMUNITIES

In this manner, the potential impacts of emissions on ambient air quality can be assessed, and air dispersion modelling and human health risk assessments performed.

Laser-induced fluorescence is used to monitor atmospheric polycyclic aromatic hydrocarbons, which are potential carcinogens and are listed as United States Environmental Protection Agency priority pollutants. These are generated from combustion processes, including diesel combustion, incineration and biomass burning.

Research is also conducted on atmospheric modelling of photochemical pollutants to be able to characterise the potential environmental impacts of emissions, for example, from motor vehicles.

Growing biotechnology in South Africa

Growing biotechnology in South Africa

More work needed to reap biotechnology benefits

The biotechnology industry is more than 30 years old and is continuing its rapid global growth. The business model for the vast majority of biotechnology companies follows a typical evolution of starting as technology developers or as service providers, then starting product development in-house and subsequently out-licensing candidates at progressively later stages of development.

Due to the high technical and market risks associated with biotechnology, the industry is largely dominated by 'pioneer' companies. Of the more than 4 000 global biotechnology companies, more than half would qualify as a 'pioneer'. Only a small portion of today's 'pioneer' companies are likely to successfully progress into the 'growth' phase, with an even smaller portion transitioning through the 'consolidation' phase[1].

The main source of funding for a platform technology company comes from venture capitalist (VC) or private equity funding. Later, as these technologies evolve further, and due to a reliance on VC funding, a clear exit strategy is usually desired within a set time frame. This typically means either becoming an acquisition target for a larger or more developed player or through an initial public offering and listing on a securities exchange.

The international biotechnology industry thrives on strategic alliances and partnerships formed around licensing agreements. Biopartnering has long been the life blood of the biotechnology industry, in supplying essential cash injections and partnered expertise.

Recent trends in the biotechnology and pharmaceutical industries have raised the importance of biopartnering to both out-licensor (the owner of intellectual property (IP)) and in-licensor (the acquirer of IP rights)[2]. Internationally, contract research organisations (CROs) play a key role in the development of platform IP offerings that form the cornerstone of new biotech start-ups, spin-offs and ongoing biopartnering within the biotechnology industry. In return, the biotechnology enterprises provide contract research and development (R&D) opportunities to the CROs with collaborative ongoing R&D through the pioneer and build-up phases.

These are exciting times for the South African biotechnology sector and over the next year we expect to see an update of the 2001 National Biotechnology Strategy document as well as a new harmonised IP policy for public institutions. More than R450 million has been spent through public funding instruments in the biotech sector over a three-year period. Although the 2001 strategy does highlight the need to invest in a select number of platforms, there is a view that government should be playing a more active role in providing greater focus in this sector.

1 Biopartnering strategies, Business Insights, December 2006
2 Biopartnering strategies, Business Insights, December 2006

The establishment of the Technology Innovation Agency (TIA) is regarded as a key structural intervention to support government in stimulating and intensifying technological innovation.

The Department of Science and Technology, in its 10-year plan for South Africa, highlights biotechnology as a key component and outlines a 'Farmer to Pharma' grand challenge. The department states that the heavy burden of disease in South Africa gives special impetus for biotechnology and/or pharmaceutical solutions, particularly to attack the diseases of poverty. The strategy envisages that innovation in biotechnology will yield creative solutions to these challenges, driven by rapid drug discovery, rational drug design and development, the validation of traditional therapies, and the advances in diagnostics, genomics, proteomics and stem cell technology that enable radical treatment and cure. The strategy also highlights that there must be a focus on genetic modification of plants and animals to facilitate the breeding cycle, improve nutrition, develop greater pest resistance and drought tolerance. It further sets a target for South Africa to become one of the top three emerging economies in the global biotechnology and pharmaceutical industry by 2018, based on an expansive innovation system using the nation's indigenous knowledge and rich biodiversity.

Financing a start-up biotech company in South Africa is a particular challenge. This is partly due to the lack of a robust VC tradition in the country. In South Africa most start-up biotech companies created after 2001 will be in either the pioneer phase or ready to enter the build-up phase. The long time it took for companies to get to this phase is concerning but growth was predominantly hampered by lack of VC investment. For the South African bio-economy to grow and develop, increased biopartnering is required as well as collaboration across all sectors (academia, science councils, industry and government). Improved funding mechanisms are also

required to close the gap between basic research and commercialisation. It includes the need for shorter turnaround times between application and receipt of funding. Local CROs play a key role in developing the core IP platforms and creative business models (i.e. licensing, venturing, co-development), through which a new biotech industry needs to be developed.

In this regard, the CSIR collaborates closely with other science councils such as the Agricultural Research Council (ARC) and the Medical Research Council (MRC). For example, the CSIR plays a principal role early in the value chain of drug discovery and preclinical development, with the MRC playing a leading role in the latter part of the value chain during clinical research and validation of drug candidates during clinical trials. Similarly the CSIR plays a role early in the genetic modification of plants with desired traits, while the ARC plays a role in the latter part of plant breeding and propagation.

Growing biotechnology in South Africa

APTAMERS: HITTING AT THE HEART OF HIV

Aptamer technology researchers at the CSIR have, with the aid of computational modelling, elucidated the crystal structure of an anti-HIV aptamer that could provide future insight into the design and optimisation of drugs that inhibit HIV entry.

This aptamer blocks gp120, an HI-virus glycoprotein that mediates fusion of the viral membrane with the host plasma membrane to allow viral entry into the host cell. Aptamers are artificial DNA/RNA molecules that have been engineered in a test tube. They are minuscule but powerful enough to bind to an antigen and prevent the virus from docking to its preferred receptor.

In the case of HIV/Aids, aptamers have specific appeal as they are able to penetrate more precisely the viral protective mechanisms resisting antibody attack. Aptamers will, however, need to be used in combination with other drugs and strategies to combat the epidemic effectively. The work has been submitted for peer review in scientific journals.

FAST FACT

The CSIR is the only organisation in Africa that works with aptamer technology. Scientists exploit this technology to investigate biomedical systems and the molecular basis of diseases for cutting-edge solutions to disease.

FIGHT AGAINST TB INTENSIFIED

Four frontline anti-tuberculosis (TB) drugs have been encapsulated successfully by the CSIR.

The CSIR research is undertaken in collaboration with various local and international institutions. The project aims to develop a nano-based drug-delivery system whereby anti-TB drugs can be administered in a reduced dose frequency, i.e. once every 10 days for a shortened time period, as opposed to the current regimen of four antibiotics taken daily for six to nine months. The new delivery system should also ensure improved bio-availability and reduced toxicity.

Once optimised, the research is positioned to have a remarkable impact not only in South Africa but also in the rest of Africa, since it holds promise for use in delivering anti-malaria, anti-retrovirals for HIV/Aids patients, antibiotics, and many other drugs.

PROMISING COMPOUNDS DISCOVERED AGAINST X-DR TB

An epidemic of extensively-drug resistant (X-DR) TB hit South Africa in 2006 with over 300 cases and more than 200 deaths reported. This deadly strain is a type of TB resistant to first and second-line drugs, leaving those affected virtually untreatable using currently available anti-TB drugs.

Structural biology researchers at the CSIR identified a novel enzymatic reaction mechanism, the inhibition of which is fatal to *Mycobacterium tuberculosis* (including X-DR strains). The CSIR synthesised about 5 000 compounds and made a breakthrough in isolating about five compounds found to kill X-DR TB, no matter what the strain, based on inhibition of this enzyme. The disease is also prevalent in Eastern Europe and Asia.

SOUTH AFRICAN PLANT SHOWS ANTI-HIV POTENTIAL

CSIR scientists agree that a key to curbing the intracellular replication of HIV is to inhibit the HIV-1 protease enzyme.

Many of the antiretroviral compounds currently available (for example Kaletra) are protease inhibitors. Sponsored by the Innovation Fund, the CSIR embarked on a new project in January 2008 to investigate the design and synthesis of compounds of a novel natural product isolated from a South African plant exhibiting anti-HIV properties.

This project is an early-stage discovery project where many different compounds based on the natural product are being prepared synthetically and tested against the enzyme HIV-1 protease in an enzymatic assay. Computer-assisted design is one of the techniques used to decide which compounds should be prepared.

CSIR researchers and their project collaborators – the University of Pretoria and Onderstepoort Veterinary Institute – aim to develop a lead compound with good anti-HIV activity that can be modified, improved and developed into a candidate drug that can undergo clinical trials.

COMPUTER-ASSISTED DESIGN IS ONE OF THE TECHNIQUES USED TO DECIDE WHICH COMPOUNDS SHOULD BE PREPARED

CSIR PATENTS TWO LOCAL HERBAL REMEDIES

The CSIR has patented two novel herbal extracts – one for the long-term management of asthma and allergies, and the other for erectile dysfunction. These formulas were isolated from 15 leads identified in 2007 for the development of therapeutic areas including mosquito repellency, asthma and allergies, arthritis, anti-inflammatory problems, wound healing, benign prostatic hyperplasia, malaria, HIV, cancer and erectile dysfunction/libido.

The herbal extract targeting asthma and other allergies demonstrated moderate activity in reducing broncho-constriction, while significantly reducing pro-inflammatory and inflammatory mediators such as cytokine Interleukin-8 (IL8) responsible for the inflammatory pathway. The results have pointed to the mode of action through which this traditional remedy acts and are the first scientific evidence that validates the traditional use of the plant for the treatment of asthma.

A drug lead for the treatment of erectile dysfunction and the enhancement of the male and female libido was identified from the validation of extracts of a medicinal plant prepared as tea by traditional healers to increase sexual drive and for the treatment of sexual malfunction.

CSIR LEADS IN BIOMATERIALS SCIENCE

Biomaterials science forms the foundation of the multibillion dollar applied medical industry. A biomaterial can be defined as any material, synthetic or natural in origin, which can be used to treat, augment, or replace any tissue, organ, or function in the human body. Accordingly, biomaterials science is a combination of materials science, cell biology and medical implant technology.

FAST FACT
Eleven papers were delivered on CSIR research activities in the field of biomaterials at the 2nd annual biomaterials symposium held by Biomaterials Association of South Africa (BioMatASA).

Biomaterials are being employed in diverse areas, such as synthetic medical implants, tissue regeneration scaffolds, drug-delivery systems and molecular signalling devices, as well as in many non-clinical applications, such as water purification and metal extraction.

Research activities at the CSIR in the materials science and manufacturing field focus on bioceramic implants for bone replacement, soft-tissue regeneration using polymeric particles, intelligent stimuli-responsive polymers, novel drug delivery formulations, and non-woven fibre scaffolds as matrices for biological applications.

EMERGING RESEARCH AREA: SYNTHETIC BIOLOGY RESEARCH PIONEERED

In 2007 the CSIR joined the ranks of pioneers with its establishment of a synthetic biology research capacity. This move positions South Africa to become a world leader in this field that is an emerging research area worldwide.

Synthetic biology marries the principles of engineering with biology and loosely defined, is the design and fabrication of biological components or systems that do not exist in nature.

FAST FACT
Synthetic biology can be applied to drug delivery systems, bioremediation, nano-surgical choices to repair individual damaged cells, and artificial implants – for example cochlea and retina implants.

The CSIR's initial focus revolves around two areas: bio-energetics (development of energy and light capturing nanodevices for application in drug delivery and nano-surgery) and molecular biomaterials (development of artificial cells for medical applications).

Expertise is combined in bioscience, nanoscience, materials science and laser-based techniques of microscopy and biophotonics. Collaboration with local research institutions is envisaged. South Africa intends to achieve international recognition in synthetic biology within the next five years.

TESTING FOR MARINE BIOTOXINS

FAST FACT
The CSIR's chemical analytical service is the only accredited facility in southern Africa equipped to test for biotoxins in shellfish products.

South Africa's aquaculture production has shown an increase over the past decade, with shellfish farming growing to an export value of about US$25 million. South Africa is now regarded as a leading producer of cultured abalone and this sector of the marine aquaculture industry continues to expand.

One of the biggest threats to the growing industry is marine biotoxins. These are toxic compounds that are extremely harmful to humans, causing shellfish poisoning. Local exporters are not permitted to export their products unless they have implemented various system controls and sanitary checks, including testing for biotoxins.

The CSIR's chemical analytical service is the only accredited facility in southern Africa equipped to test for these biotoxins in shellfish products. The work done by the CSIR contributes significantly towards managing and minimising the risk of disease and poisoning associated with the consumption of molluscan shellfish.

Conventional and traditional medicine combine forces

A new research partnership was established between the CSIR, the Global Research Alliance (GRA) and Tanzanian traditional healers and health officials in August 2007. It paves the way for dialogue between executors of conventional and traditional medicine to explore Africa's biodiversity and find solutions to global health challenges.

The Tanga Aids Working project, named after the Tanzanian region where it originated and the focus of the collaboration, is a flagship project of the GRA. It is also endorsed by the World Bank through its indigenous knowledge systems programme.

The CSIR, a member of the GRA, has thus far contributed project management skills and assistance with a technical plan for further development of potential drug leads. These will be sourced by validating traditional herbal remedies surfacing among traditional healers.

Expertise in edible films secures part of EU project

The CSIR was invited to join the Novel Q consortium in 2007, based on its research expertise in extracting underutilised proteins from grains.

Novel Q is funded by the European Commission within Framework Programme Six and culminates in 2009.

The CSIR's role is to investigate the extraction of purified cereal proteins from sorghum brewers' spent grain (a waste product from the sorghum beer brewing), millet and oats. It has to scale up protein-extraction protocols from laboratory to bench scale (16 litre) and ultimately pilot scale (75 litre) for generating sufficient amounts of protein for use as edible coatings for vegetables (carrots, broccoli) and fruit (tomatoes, strawberries). The coatings are formulated to extend the storage life of the products without reducing their fresh appearance and texture.

FAST FACT

The 39-member consortium of international principal scientists that make up Project Pharma-Planta has produced 75 publications in the four years since the project came into existence. Read more at www.pharma-planta.org/publications.htm.

Plant-made pharmaceuticals receive a boost

In early 2007, the Department of Science and Technology awarded the CSIR a substantial grant for research into plant-made pharmaceuticals (PMPs).

Such pharmaceuticals involve the genetic engineering of plants that enable them to produce certain types of therapeutically-important proteins and associated molecules that can be harvested and used to produce pharmaceuticals.

The multi-million rand grant enables CSIR plant biotechnologists to extend their research into transgenic plants as a novel platform for the production of PMPs. This work is part of the CSIR's contribution to the European Union-funded Pharma-Planta initiative – an international consortium researching plant-expressed clinical-grade pharmaceuticals against various diseases, including HIV and rabies.

The project could revolutionise the production of some pharmaceutical proteins and increase the competitiveness of existing South African pharmaceutical industries, while also stimulating the entry of new players into the industry.

Improved Infrastructure & services for South Africa

Improved Infrastructure & services for South Africa

Potential to power socio-economic development

The built environment and infrastructure are powerful drivers for socio-economic development. The South African government recognises this through policies such as the Accelerated and Shared Growth Initiative for South Africa (AsgiSA); its intent is clear from the marked increase in funding for infrastructure development in South Africa over the next five years (in excess of R400 billion).

In response to challenges experienced in the areas of infrastructure and the built environment, the CSIR focuses its efforts in this domain on planning support systems; infrastructure engineering; construction; architectural sciences; infrastructure operations; logistics and quantitative methods; and rural infrastructure and services.

Future challenges

Over the next three years, the following broad infrastructure areas will receive CSIR attention:

- Advanced materials, including nano-phosphor materials, natural fibre composites, cement and bitumen replacements, advanced road building materials, the use of marginal materials and advanced building systems, and materials for houses
- Advanced methods for the optimisation of infrastructure planning, design, construction and operation (including infrastructure investment decision support; road, airport and port design; modern methods of construction; logistics and supply chain management; public transport and traffic management)
- Advanced urban design through, *inter alia*, the modelling of urban and regional dynamics
- Climate change mitigation through the optimisation of design and operation, specifically alternative energy sources for buildings, zero-energy closed-loop systems, methods to minimise energy consumption in the construction and operation of infrastructure, and minimising energy use in transport
- Distributed service provision for communities including water, electricity and sanitation
- Advanced modelling techniques to understand, solve and address complex problems
- Intelligent systems including intelligent transport systems.

Partnering

Government departments that partner with the CSIR in the area of infrastructure and the built environment include the national departments of Public Works; Provincial and Local Government; Housing; Transport; and Health; the National Treasury; and several provincial and local government departments. The CSIR also works closely with a number of parastatals, private sector associations, professional bodies and financial development institutions.

The CSIR fosters and maintains strong relations with international stakeholders and partners in this area, including the California Department of Transportation, the University of California at Berkeley and Davis, the Technical University of Delft, Georgia Tech, CRRI of CSIR India, CNRS in France, and Harvard University.

Current situation

- The construction industry is growing at more than 20%, with shortages of human resources and a demand for advanced technologies
- In 2005, the South African Institute for Civil Engineers (SAICE) rated the majority of infrastructure to be in either a fair, poor or very poor state
- The cement industry worldwide emits more than 1,4 billion tons of carbon dioxide; a strong need exists for advanced materials and replacement of existing cement-based materials such as concrete
- Iron and steel manufacturing uses 4% of global energy; the price of construction steel is increasing rapidly, which also calls for alternative material development
- More than 50% of the world's people are living in cities; this demands alternative city design and alternative technologies for services, infrastructure and transport systems to provide sustainable livelihoods
- Logistics costs in SA are more than double that in developed countries and are now at 15%, causing South Africa's export businesses to be less competitive internationally
- The high economic growth over the past number of years is causing significant stress on infrastructure in the country, particularly on buildings, services and the transport system. For example, the N3 road to Durban has in the past three years carried the same amount of traffic than in the previous 20 years, leading to structural capacity problems
- In rural areas (and some underdeveloped areas in cities) huge backlogs exist in housing and services, which demand special technologies to construct housing faster and better, provide off-grid energy and services, provide access, as well as health and educational infrastructure
- The Human Poverty Index in South Africa has worsened from 16,4% in 1995 to 31,7% in 2002 – a growth of 1,7 million people living below $1 per day, creating specific needs for basic infrastructure and services.

Improved Infrastructure & services for South Africa

RESEARCH SUPPORTS ALIGNMENT OF GOVERNMENT PLANNING

CSIR research on planning support systems plays a leading role in application of the National Spatial Development Perspective (NSDP). The Presidency has launched a national project on a pilot basis to contextualise and apply the NSDP within districts and metros, to strengthen the integrated development planning process and to promote the district as a shared unit of analysis and planning between the three spheres of government.

The CSIR provides technical guidance to The Presidency in the development of planning technologies in each of the 13 participating district municipalities, and one metropolitan municipality. The CSIR also manages the NSDP on behalf of The Presidency and its key partners (German-based development agency GTZ, the Department of Provincial and Local Government and the Development Bank of Southern Africa).

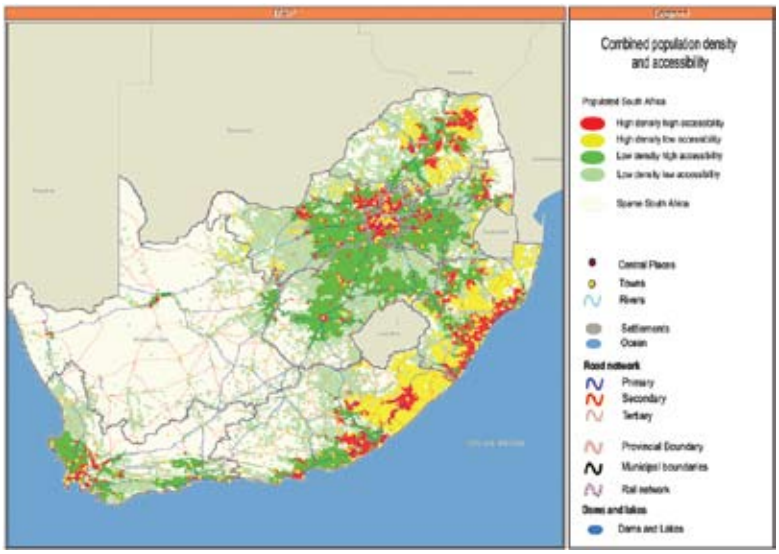
The geospatial analysis platform developed and updated by the CSIR makes a crucial contribution towards enabling a comparative analysis of the development potential and challenges in the various district and metropolitan areas. Lessons learned in the first implementation phase will be used to deepen understanding, identify key issues, inform strategic planning processes and instruments in government, and form a platform to implement the framework in all district and metropolitan municipalities by 2008/09.

AUTOMATED ROAD EXTRACTION ACHIEVED

A great number of geographic information systems applications – such as transport planning and satellite navigation – require up-to-date road network data. Not only do large areas remain unmapped, but accurate maps are not available to the general public as these are very expensive to produce.

Remote sensing researchers of the CSIR's Meraka Institute use automated feature extraction of satellite images to identify geographic features and in this case, define their extent to build road networks. The process involves classification of images by looking at the structural (shape) and spectral (colour) properties of roads. The outputs are then combined in a process called data fusion. The final step is network building, during which artificial intelligence is used to link all the pieces of road and to filter out the background noise.

The benefits of this process are reduced costs and processing time, repeatability, and improved traceability and consistency.



FAST FACT

Observations supply transport information:

Timely information on complex traffic networks and movements is of significant importance to South Africa. The CSIR's NyendaWeb aims to achieve a collaborative, coherent, consistent and consolidated intelligent transport-traffic-related sensor data collection, fusion and distribution system. NyendaWeb is built on the sensor web platform, which will ultimately establish an extensive monitoring and sensing system, providing timely, comprehensive, continuous and multi-mode observations.

TOOL PRODUCES DETAILED MAPS OF ECONOMIC GEOGRAPHY

A new digital mapping and geographic analysis platform (GAP) enables researchers and decision-makers to estimate the spatial distribution of economic activity in South Africa in greater detail than ever before. An analysis of GAP statistics, together with variables such as population, relative geographic position and land capability, indicates that 99,8% of South Africa's economic activity and 99,2% of the population settlement occur on only 55% of the surface area.

The densely populated, core economic areas are concentrated mainly in the northern and eastern parts of the country, with the division being a line that stretches from Kimberley in the north to East London in the south.

The results of the collaborative project have already been used in updating or developing a number of national strategies and perspectives, including the NSDP. Since GAP also contains a digital road network and a new geo-referenced dataset of South Africa's towns, it can be used to produce a variety of distance, travel time or transport cost maps. Further information on GAP is available at **www.gapweb.co.za**.

Ken Breetzke, Strategic Executive in the Engineering Department at eThekwini Municipality – The CSIR has developed a procedure for undertaking facility service access planning, modelling and mapping to identify spatial gaps in service provision. This has led to significant savings for the eThekwini municipality.
One outcome is that about 30 000 more people will be able to access a library to be built in Inchanga, following the CSIR's assessment of where the best location for the library would be.

"Your maps won the argument for us... This means that more people will be able to access the library and hence there is a bigger reduction of backlogs. Keep up the good work."

DATABASE CREATED OF INFORMAL SETTLEMENTS

TIME-SERIES ANALYSIS IS USED TO ASSESS TRENDS AND DETERMINE PROJECTIONS OF THE EXTENT, NATURE, AGE AND GEOGRAPHICAL DISTRIBUTION OF INFORMAL SETTLEMENTS

On-site upgrading of informal settlements by the North West province is a priority to promote delivery of security of tenure, municipal engineering services, socio-economic amenities and housing opportunities. Reliable information regarding these informal settlements is imperative to ensure the quality and effectiveness of planning of the North West Informal Settlement Upgrading Programme.

The CSIR has created a current, reliable and functional database on informal settlements in North West using 2005/06 SPOT 2,5 m natural colour images to form a 2006 baseline informal settlements database.

Time-series analysis is used to assess trends and determine projections of the extent, nature, age and geographical distribution of informal settlements. Through access to its data archives, data can be extracted back to 2004, which can then be identified and analysed using the 2006 baseline. Very high resolution images like Quickbird and aerial photographs are used to count the number of dwellings.

URBAN GROWTH MODELLING FOR BETTER SERVICE DELIVERY

Urban and regional planners are seeking ways to enhance the quality of life of inhabitants through improved spatial planning. The physical form of cities and settlements is the result of many interacting, dependent and independent decisions and actions.

Any change to the system, both intended and unintended, can take many years to manifest, often with unforeseen consequences.

Urban and regional planning models enable scientists and designers to explore, predict and plan these environments prior to acting in some irrevocable way. The ability to experiment on simulations of the real world instead of the real world itself is crucial in testing alternative development concepts and hypotheses for more sustainable urban and regional futures.

CSIR research supports key service-delivery line departments at national, provincial and local spheres to enable these to achieve infrastructure investment and development spending that are aligned, focused and directed, in terms of location and form. Thus sustainable and maximum impact is ensured through service delivery of the right kind and amount, in the right place and at the right time.

DRASTIC CHANGES TO FREIGHT NETWORK NEEDED TO PREVENT GRIDLOCK

South Africa's fast-growing economy and the increase in freight movement and traffic volumes are placing huge pressure on the country's already strained logistics infrastructure. Road transport has increased, whereas rail transport tonnages have remained more or less stagnant for the past decade. It is clear that revolutionary change is required in the long-haul road/rail relationship to avoid road gridlock.

This is according to the third annual State of Logistics survey, authored by the CSIR and Stellenbosch University. The survey explores the challenges of implementing logistics strategies in the macro-economic, industry and small business development contexts.

The fast-moving consumer goods sector and government service delivery have their own set of challenges, with goods and services to be delivered over the entire national geography, and ineffective supply chains impacting consumer satisfaction directly.

To support sustainable change in the logistics industry, the survey identifies a number of critical issues and actions, including continuous commentary on the industry by the research and consulting community; transfer of learning between established and upcoming industries; and localisation of global practices by logistics service providers.

FAST FACT

South Africa's logistics costs were 14,5% of the GDP in 2005, a slight decrease from 14,6% in 2004 and 14,8% in 2003.

The total land transport in the South African economy increased by 8% to 1,4 billion tons.

PAVEMENT DESIGN REVIEWED FOR IMPROVEMENT

South Africa has a high standard primary road network and the country has a proud history in road pavement engineering. Maintaining this in the face of increasing traffic needs an improved system for modelling and designing road pavements.

The CSIR played a key role in the development of the initial South African pavement design method (SAPDM) for roads, which has formed the backbone of design methods. The new traffic realities have, however, rendered important parts of the method obsolete and in dire need of serious revision. More than 20 project proposals aimed at improving the SAPDM have been submitted to the South African National Roads Agency Limited for consideration.

CSIR pavement engineers have developed a software tool – soon to be released to industry – that simulates actual road pavement behaviour. The output has been compared against results from software packages worldwide and preliminary results show a high degree of accuracy and efficiency for analysis of static loading cases. It is expected that successful development of this software will provide pavement engineers with a tool that simulates actual pavement behaviour closely.

FAST FACT

Infrastructure and related projects that have been completed successfully by the CSIR (through the use of mathematical modelling) include:

- **Development of an operations control system for South African Airways**
- **Development of an optimal distribution model for Engen**
- **Development of various resource allocation models for the South African Police Service and the Directorate of Special Operations (Scorpions)**
- **Development of a vehicle scheduling system for South African Breweries**
- **Optimal location of depots for Omnia Fertilizer**
- **Optimal introduction of kilns within a given planning horizon for Blue Circle Cement**
- **Development of complex simulation models for Sasol**
- **Development of models to forecast South African election results**
- **Development of accessibility models for the location of facilities for the Department of Home Affairs**
- **Development of electricity demand forecasting models for both government and industry**
- **Development of a large optimisation model for the forestry industry.**

FOCUS ON AGRICULTURE SUPPLY CHAINS

The CSIR aids the agriculture sector through mathematical modelling of supply chains in the wine, sugar and fresh fruit industries.

Wine

The CSIR team lends decision support to wine cellars when grapes are scheduled from different suppliers to different tipping bins, when wine makers have to reschedule if agreed-upon amounts of grapes cannot be delivered to the cellar due to unforeseen problems, and for solving layout problems concerning the floor plan and pipelines for a cellar. The research project forms part of a drive to establish an international wine industry supply chain research network.

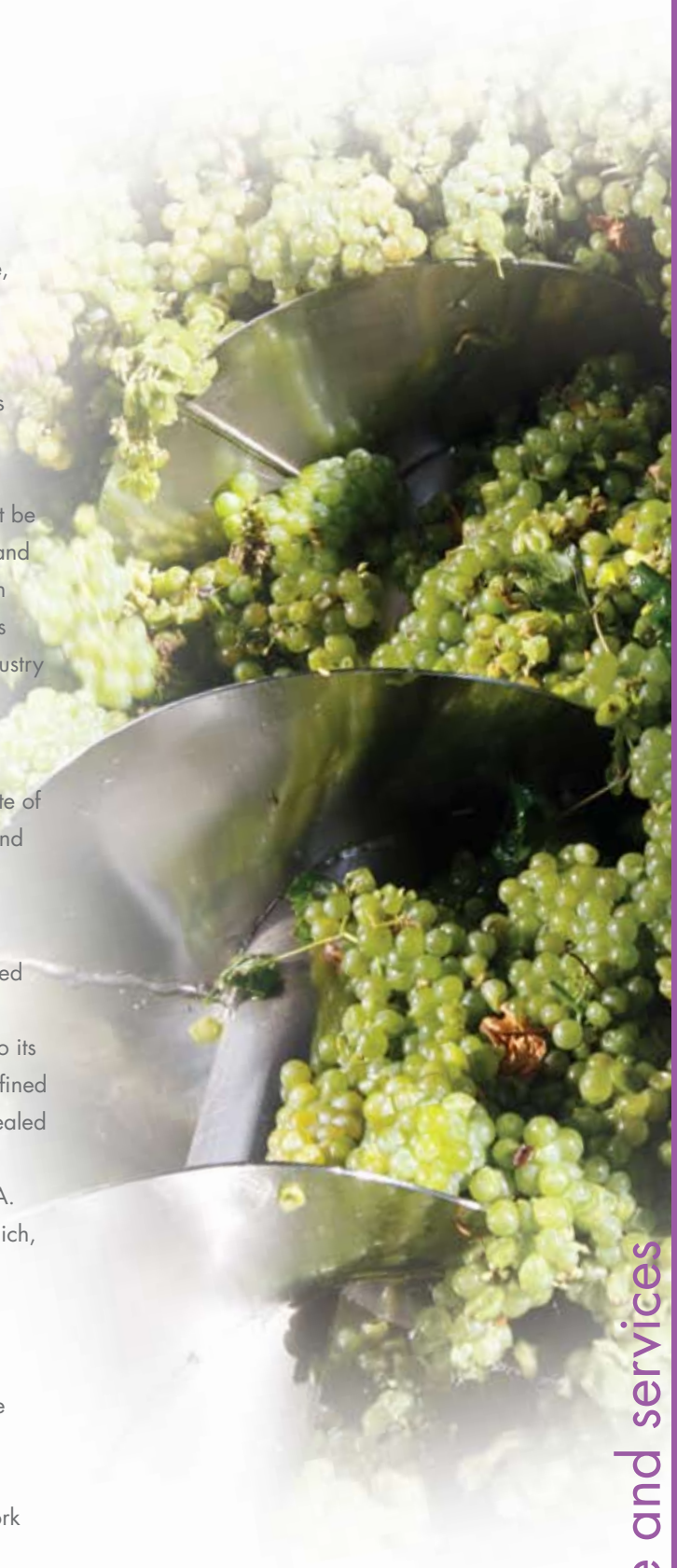
The network, which will collaborate on global wine supply chains, includes the CSIR, the Georgia Institute of Technology (USA), the Catholic University of Chile and CSIRO in Australia.

Sugar

The Swaziland Sugar Association (SSA) commissioned the CSIR to improve the association's supply chain. Researchers modelled the SSA's sugar cane supply to its mills as well as the delivery chain of refined, semi-refined and raw sugar products to customers. The study revealed a number of sub-optimal practices that result in over-capitalisation; these are being addressed by the SSA. Certain pricing anomalies were also discovered, which, if rectified, could lead to significant savings to the industry.

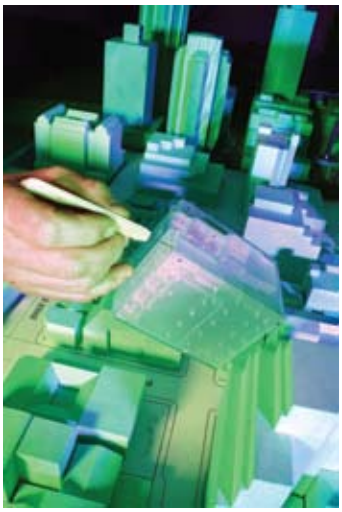
Fresh produce

Simulation models were developed for fresh produce terminals in Cape Town and Durban to analyse the flow of produce. The maximum volume of produce that can be handled by certain sections of the network was established, while a model was developed to determine the current and potential future use of the various terminals that load fruit for export. These models were used to determine whether investment in logistics infrastructure would be required in the foreseeable future. The simulation model prevented the fruit industry from making costly investments in inappropriate infrastructure.



THE RESEARCH PROJECT FORMS PART OF A DRIVE TO ESTABLISH AN INTERNATIONAL WINE INDUSTRY SUPPLY CHAIN RESEARCH NETWORK

WIND ENGINEERING IMPROVES DESIGN OF STRUCTURES



THE CSIR WAS COMMISSIONED TO CONDUCT TESTS ON THREE LARGE SPORTS STADIA IN PREPARATION OF 2010

Development teams involved in the 2010 FIFA event commissioned the CSIR to conduct tests on three large sports stadia in 2007. Wind engineering is used to quantify the interaction between wind and structures, enabling the design and development of a new generation of super-tall buildings and long-span cable-stayed bridges.

The CSIR obtained specific design inputs through wind-tunnel modelling of the stadia, including areas envisaged for spectators (e.g. galleries, passages); wind conditions over the pitch affecting the spectacle and fairness of the game; environmental wind impact of the stadia; optimisation of the form and extent of the roofs; the determination of the design wind loadings and structural response of the grandstand roofs, which are significant (for areas of 20 000 to 30 000 m^2, wind uplifts greater than 1 000 tonnes).

Wind-tunnel modelling is used largely for unusually-shaped or sized buildings and structures, or those to be placed near other large structures. The CSIR has undertaken several studies of building developments in South Africa, such as the Table Bay Hotel, the Cape Town Convention Centre and the San Raphael building in Durban. In addition, the CSIR has developed a geographical model of zones of strong wind occurrence in South Africa and a comprehensive risk model of wind damage and disaster for South Africa.

INDICATORS TO IMPROVE SCHOOL INFRASTRUCTURE

Some schools in South Africa have good infrastructure, while others don't even have the basics such as adequate water and sanitation services. The CSIR has identified critical aspects of school infrastructure needed to support quality education, and developed an assessment framework to ascertain performance.

The vast differences in school infrastructure provision raise key questions, including whether most resources should be allocated to infrastructure-poor schools; which aspects of school infrastructure should be tackled first; and how to ensure prioritisation of urgent backlogs while still securing overall improvements.

Initial project findings indicated that planning systems have to balance addressing urgent needs for basic services, while continuing to improve education infrastructure in all schools. The study measures school infrastructure performance against 15 criteria, five in each of the areas of people, infrastructure and programmes. The envisaged output is a system to be used by departments of education, physical planners and schools.

MOVING TOWARDS MIXED COMMUNITIES OF MEDIUM DENSITY

The development of sustainable and affordable housing remains a challenge in South Africa. Worldwide, medium-density mixed housing (minimum of 50 dwelling units per hectare – du/ha – and a maximum of 125 du/ha, ground-level entry with private external spaces and close proximity to secure parking) is becoming increasingly popular for addressing this challenge.

International studies indicate medium-density mixed housing has a positive impact on the quality of the built environment, as well as a huge social impact, including the potential for interaction between different social and income groups and reduced negative area effects.

The CSIR is conducting research to determine key factors for the successful development of medium-density mixed housing (including affordability and sound investment, neighbourliness, safety and security, and design and layout).

Research also aims to establish whether requirements for success could be met in the South African context, and if so, how to support this through creating an enabling environment.

TECHNOLOGY AIDS SAFE HARBOUR OPERATIONS

Technologies to monitor and analyse environmental data in real time have been developed by the CSIR for making harbour operations safer and more efficient. These technologies include an integrated port operations support system and WaveNet, currently a network of seven wave stations. The project is undertaken for the National Ports Authority (NPA).

Data are collected on waves, currents, tides, water quality and wind. While real-time information is provided, the data are also archived for future use. WaveNet comprises, among others, a base station on shore and a directional Waverider buoy that measures wave height, period and direction as well as sea surface temperature. Buoys at Cape Point, East London and Richards Bay have global positioning systems to assist tracking.

Data collected by the CSIR over the past seven years are being used by the NPA in a project to widen and deepen the entrance channel to the Port of Durban. Since environmental data collected are valuable for forecast purposes, an access link has also been established for the South African Weather Service.

Infrastructure expanded at CSIR ground station

For owners and operators of all types of satellites, it is important to be able to communicate with their satellites. Satellite earth stations or ground stations worldwide must ensure that their infrastructure is in pristine working condition, up-to-date and available for use as required by clients. Located some 70 km west of Pretoria in the Magaliesberg mountain range, the CSIR's ground station is ideally positioned to support geo-synchronous and polar orbiting spacecraft and also to receive data from satellites.

The main CSIR earth observation data catalogue is for Landsat 4 and 5 MSS; Landsat 5 TM; Landsat 7 ETM; SPOT 1, 2, 4 and 5; ERS 1 and 2 and NOAA sensors. In support of its commitment to offer its clients a world-class infrastructure, the CSIR erected its 10th full-motion antenna, which operates in Ku band, at Hartebeesthoek with funding from Intelsat. Its oldest antenna, the 12 m one that operates in the C band, has been upgraded to ensure ongoing support for long-time customer CNES. A new X band antenna has been purchased and will be commissioned in 2008.

FAST FACT

In the Khalifa Port project, the CSIR collaborates with:

- **The Abu Dhabi Ports Company**
- **Halcrow**
- **Stellenbosch University**
- **Delft University of Technology**
- **Murray & Roberts and WSP Coastal Africa, under the umbrella of the Centre for Port Research and Training (C-PoRT).**

Modelling of multi-billion dollar port development

The CSIR's hydraulics laboratory in Stellenbosch is conducting physical model studies for the development of a multi-billion dollar port in the United Arab Emirates. The Khalifa Port, between Abu Dhabi and Dubai, is one of the largest multi-purpose maritime facilities in the world, covering an area of 2,2 km².

The R10 million contract is, to date, the biggest (in South African rand terms) model investigation ever carried out by the CSIR. It is anticipated that more work will follow. This contract was obtained in competition with international laboratories, which indicates that the CSIR's hydraulics lab is considered world class. The lab, one of the leading 10 in the world, is used for coastal and port engineering research.

The port will be developed in five stages; when the first phase is completed, the port will have an estimated annual throughput of two million 20-foot equivalent container units, and over six million tonnes of general cargo. The CSIR is evaluating the layout and design of the first phase, with studies focusing on the design of the extensive breakwaters to protect the port against waves and on the mooring conditions of container vessels and bulk carriers in the port.

Satellite applications to be boosted in southern Africa

Readily available navigation systems such as the global positioning system (GPS) are widely used as an aid to navigation worldwide, and a useful tool for map-making, land surveying, commerce, scientific uses, and hobbies such as geocaching. Galileo, Europe's own global navigation satellite system, will provide an even more accurate, guaranteed global positioning service under civilian control.

Working with lead partner Thales Alenia Space on the AFSAGA Framework 6 project funded by the European Commission, the CSIR identified a number of potential applications for a combination of Galileo and satellite communications in South Africa and the southern African region.

These are in sectors as diverse as health, tourism, management, fisheries, ornithology, the built environment and traffic control and regulation. Combined navigation and communications applications can be of interest to numerous companies, presenting niche business opportunities.

One dot per house to aid service delivery

Effective delivery of basic services such as electricity and water, and urban planning are dependent on, among others, reliable data for planning and implementation. Geo-referenced data provided by the CSIR can aid the delivery of various basic services.

The CSIR is mapping the location of dwelling units for the whole country using SPOT 2,5 m high-resolution multispectral satellite imagery acquired over the period 2005/06. Although this will be used to quantify the existing electrification backlog for the client, Eskom, the points representing the location of dwelling units are also an invaluable planning tool at regional level.

Once captured, point and density polygon data (i.e. points representing the location of dwelling units or polygons for dense areas such as dense informal settlements) will be analysed against proclaimed land (land that is electrifiable and areas with existing Surveyor-General cadastral coverage), tribal and non-proclaimed land.

This geo-referenced dwelling frame will become the sampling frame for household surveys and the frame for conducting population and housing censuses in South Africa.

Rendering ground station services

Once in orbit, constellations of satellites need routine maintenance to perform optimally as a return on investment. As part of a worldwide network of ground stations, the CSIR ground station at Hartebeesthoek performs regular housekeeping operations on a number of low earth orbit and geostationary satellites, and has supported a number of satellite launches.

Operating on a 24-hour a day schedule, the CSIR rendered tracking, telemetry and command (TT&C) support to a number of European and US satellites during the past year. Clients included Boeing Satellite Systems, Boeing Launch Services, Intelsat/Lockheed Martin and Intelsat, CNES and Honeywell.

FAST FACT

A new Telestat contract and an extension of the CNES contract attest to the confidence in the CSIR displayed by its international client base.

A singular case was the support for the Time History of Events and Macroscale Interactions during Substorms (THEMIS) constellation, underway since February 2007, when the CSIR received the first signals from the five science satellites or probes lifted by a Delta 2 rocket. The satellites were untraceable for 24 hours following the launch and separation from the launch vehicle and the CSIR was the first ground station to find and acquire the probes for Honeywell. On 18 November 2007, the THEMIS team celebrated the completion of electric field instruments' deployment of Probe 1 and a fully configured and 'checked-out' operation constellation.

Vassilis Angelopoulus of THEMIS Operations in Berkeley, California, notes –

"Congratulations on a job well done... the constellation in position with all instruments deployed is a dream come true for science!"

Common international address standard advocated

CSIR researchers and peers from the University of Pretoria and organisations in Denmark, the United States and the United Kingdom are advocating a common address standard.

Addresses encompass more than postal delivery: One needs these to open bank accounts, obtain identity documents and employment, vote or receive goods and services. Past and current international initiatives will be combined in an effort to explore options.

Benefits would include seamless access to address information across boundaries, which is vital in disaster management and emergency situations, as well as improved quality and address management for online retailers and courier companies.

Such a standard would promote interoperability and re-usability of address-related software tools by providing one common framework for developers. The standard will aid the development of spatial data infrastructures, particularly those spanning national borders, and facilitate data discovery through geospatial portals.

Advanced technology for South Africa's industry


D1
0.00
D2
0.00
HV
0.00
OK
TABLE1
HV
10gf
Lens X50
Stop
Focus+Read
Read
Load+Read
Load
MECER

Advanced technology for South Africa's industry

Innovative technology can aid industry

The manufacturing sector is the nation's second largest employer, contributing some 18,5% of national GDP and more than 50% of South Africa's exports. Our country has a well-established and resilient manufacturing base dominated largely by food-processing, the production of chemicals, iron and steel, metal products and machinery. Important sub-sectors include beverages, electronic machinery, motor vehicles and parts, textiles, metalworking and fertilisers.

In the medium-term budget policy statement tabled in October 2007, South Africa's GDP is projected to grow by 5,1% in 2008 and the average growth in the local economy is expected to be in the order of 5% over the next three years.

Figures released by Statistics SA at the same time illustrate an overall manufacturing output growth in volume terms of 5,1% from August 2006. The trend in real growth is encouraging – 3,1% for 1999–2003; 4,8% for 2003–2006/7 and 5,6% anticipated for 2008–2015. This longer term bullish outlook is premised on several factors, including maintaining capacity utilisation above 85%, continued growth in manufacturing fixed investment, further growth in the construction and infrastructure development programme, and a continued high local demand for manufactured goods.

It is expected that consumer spending may decline owing to higher interest rates and the National Credit Act, but this downward movement will be off-set by a 4–5% employment growth and concomitant higher demand for durable/semi-durable capital goods, as well as an upward wage drift insulating most consumers from the higher inflation level. On the constraint side, the Bureau for Economic Research reported in September 2007 that the majority of manufacturers still rate the shortage of skilled labour as the most serious problem in this sector, followed by a shortage of raw materials and then rising interest rates. The rate of increase in average labour cost per unit of production is also at an all-time high and is hurting manufacturers.

The government has recognised that South Africa's economic growth will not be sustainable if driven by raw materials exports and that it is imperative to continue developing a diversified, export-orientated manufacturing base. Recently it was also noted that the country's export performance is strong in base metals, automotives and some chemicals, but inconsistent or weak in other manufactured exports. It is imperative that more export revenue is earned to balance the rising deficit on the current account (currently 6,7% of GDP vs. 6,2% in 2006).

The South African manufacturing sector has the potential to compete globally. Future competitiveness, however, depends on its ability to master advanced technology domains and to move increasingly from raw material-intensive manufacturing towards knowledge-intensive goods and services.

The strategic intent of the CSIR in this regard is to improve industry competitiveness, national human resource development and quality of life for all South Africans through conducting leading research and innovation, with partners and stakeholders.

The science and technology environment in which the CSIR operates in this arena is largely determined by the National Research and Development Strategy, the Integrated Manufacturing Strategy and the Advanced Manufacturing Technology Strategy (AMTS). The Africa Science and Technology Strategy is also an important reference.

The National Industrial Policy Framework (NIPF), released in early August 2007, is seen as the cornerstone of an overarching policy thrust to place South Africa on a high-growth trajectory. A primary role of this policy will be to foster and expand value-added manufacturing and exports through strategic and structural interventions over a broad front.

Four lead sectors have been identified for priority support: capital and transport equipment and metals fabrication; automotive and components manufacture; chemicals, plastics fabrication and pharmaceuticals; as well as forestry, pulp and paper, and furniture.

Once successfully implemented, the NIPF will enable South Africa to join the global club of high-growth emerging economies.

Advanced technology for South Africa's industry

NOVEL ROBOT DEMONSTRATOR BEING DEVELOPED

A novel robot using parallel technology and designed according to the mechatronics engineering approach is being developed by the CSIR. The technology demonstrator is intended for industrial use as either a welding or spray-painting robot. Current robots that perform these operations are serial in nature and are bulky, heavy and expensive machines that carry only a welding torch or spray gun.

Mechatronics is the synergistic combination of several engineering disciplines, consisting of technologies from mechanical, electronic, control and software engineering.

With the rapid advance of electronic technology, designs that were once purely mechanical are now best accomplished with electronics or a combination of both. Traditional mechanical solutions in modern machinery are being improved on or replaced by mechatronics solutions. This approach holds benefits to the industry, which include:

- Modularisation
- Enhancement of features and functionality
- Precision control
- Improved efficiency
- Lower cost
- Flexibility in design
- Increased reliability
- Size reduction
- Increased safety.

SCIENCE FICTION INTO SCIENCE FACT WITH ADVANCED MANUFACTURING

CSIR manufacturing research and development focus on appropriate technologies to facilitate the advancement of manufacturers to higher operating domains. It centres on the collective concepts of advanced robotics and micro-manufacturing.

Research focus areas are the development of digital/micro-manufacturing techniques; affordable, flexible and intelligent automation systems, and advanced robotics and intelligent autonomous systems. Through the creation of intellectual property and establishing a knowledge base in these fields, the area can contribute considerably to the manufacturing industry in South Africa.

First to be scrutinised will be the medical field with microfluidics that can be used in drug discovery and medical diagnostics. Another area is in energy, looking at micro fuel cells. Other notable initiatives include the Advanced Manufacturing Technology Laboratories. This is a joint venture between the CSIR, the Nelson Mandela Metropolitan University, the Innovation Fund, the Automotive Industry Development Centre (AIDC) and LN Manufacturing to develop technologies and conduct training for local industry needs.

Research focuses on the SmartFactory concept through which affordable automation is sought to assist small, medium and micro enterprises. Automation solutions developed are based on open source software, which will operate either with industry-standard sensors and actuators or with custom-developed low-cost sensors. The CSIR has developed a system that operates in a 'plug-n-play' fashion.

CSIR ACQUIRES AUTONOMOUS SYSTEMS PLATFORMS

Several fascinating autonomous systems platforms have been acquired by the CSIR for research in this field – described as the next great step in the fusion of machines, computing, sensing, and software to create intelligent systems.

Being the physical embodiment of machine intelligence, these systems are capable of interacting with the complexities of the real world. They comprise sensors intelligently linked to control and actuation, and may communicate and cooperate to achieve complex tasks. They are designed to perform tasks that people cannot do well or safely; or those tedious, repetitive tasks nobody wants to do.

The CSIR is undertaking several projects utilising an autonomous underwater vehicle mobile service robot and an autonomous unmanned aerial vehicle for use as platforms for new applications.

Autonomous systems will bring enormous sociological and economic benefits through improved human safety, increased equipment utilisation, reduced maintenance costs and increased production.

AUTONOMOUS SYSTEMS WILL BRING ENORMOUS SOCIOLOGICAL AND ECONOMIC BENEFITS THROUGH IMPROVED HUMAN SAFETY, INCREASED EQUIPMENT UTILISATION, REDUCED MAINTENANCE COSTS AND INCREASED PRODUCTION

EMERGING RESEARCH AREA: ROBOTICS RESEARCH GETS EVEN MORE INTELLIGENT

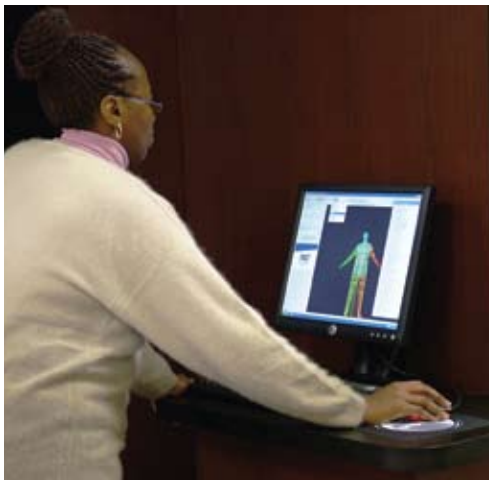
THE CSIR'S EMERGING RESEARCH AREA WILL FACILITATE CUTTING-EDGE RESEARCH IN INTELLIGENT FIELD ROBOTICS

Just over a year ago, the CSIR committed to developing a relevant research agenda that will facilitate cutting-edge research in intelligent field robotics. The CSIR's new mobile intelligent autonomous systems research area has made significant headway to date. Additional staff were recruited, new offices built, while the latest editions are a robotic platform worth over R1 million and a R1,5 million 3D ladar (laser distance and ranging) scanner.

The robotic platform is able to wander randomly; simulate behaviours offline; and map warehouses, workshops and other environments.

In addition, a haptics (technology that interfaces the user via the sense of touch by applying forces, vibrations and/or motions to the user) laboratory has been set up and a high-fidelity haptics device purchased.

TECHNOLOGY TO ENHANCE GARMENT COMFORT



Revolutionary technology techniques to ensure garment comfort for South Africans are being employed by the CSIR's fibres and textiles technology area.

One such, the South African Sizing Survey (SizeSAfrica), will provide the clothing industry with accurate and exact 3D body measurement data to develop sizing charts to fit the uniquely-shaped South African body profile.

SizeSAfrica is the first national electronic survey to be conducted on the South African population using a 3D body scanner to capture between 100 and 200 landmark measurement points of both the upper and lower body in six seconds. Using 3D technology, more accurate and exact measurement information can be obtained from the 3D surface cloud form of the subject. The method is quick, non-intrusive and uses white light to capture the 3D scan.

THE TEST OF QUALITY

The South African textile and clothing industry is facing enormous challenges regarding competition. To secure its sustainability, the industry needs to compete globally by producing quality products in an environmentally-friendly manner.

The CSIR has been contracted by Woolworths to handle all auditing and correlation of its 47 local textile suppliers. As correlator or auditor, the CSIR is tasked with annually auditing, correlating and certifying all these supplier laboratories to the satisfaction of Woolworths.

It has to ensure readiness and compliance when the CSIR laboratories themselves are audited by a representative from Specialised Technology Resources (UK), a Marks & Spencer's accredited laboratory.

CSIR AND DENEL COLLABORATE ON LASER WELDING

Denel, the largest manufacturer of defence equipment in South Africa, is collaborating with the CSIR on the use of laser welding in the manufacture of rocket motor casings. The venture has been in a trial phase since 2005, but has now been formalised after the CSIR proved the effectiveness of its laser welding expertise. With this initiative, the CSIR has proven that it can provide a reputable and reliable joining process in areas subject to high mechanical stress.

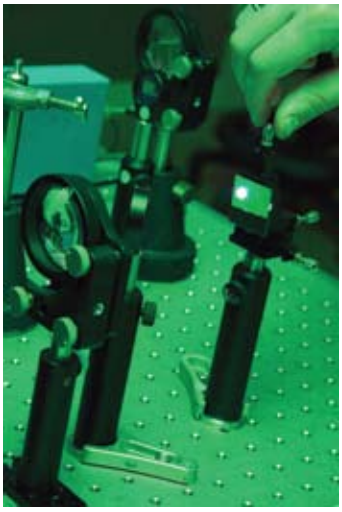
Denel operates in the military aerospace and landward defence environments. Its sole shareholder is the South African government. It is hoped that this venture will give Denel the competitive edge over other defence equipment manufacturers, which will have benefits for the South African economy.

CSIR MAKES HEADWAY IN FEMTOSECOND SCIENCE

In less than a year, the CSIR's femtosecond science laboratory has made headway in matching international advancements in this technology. What makes femtosecond pulses unique are their extremely short duration. Noteworthy is the study of matter properties during these short timescales (femtosecond spectroscopy) and then controlling the chemical reactions. Already, CSIR laser scientists have achieved the following 'firsts':

- The first femtosecond pulse length measurements using a CSIR-built intensity autocorrelator was set up in a short time
- The first femtosecond frequency-resolved optical gating (FROG) measurements were done and the technique developed and applied as a diagnostic tool
- The first complex pulses were generated and measured. This was done in a unique set-up using two beam-splitters, which demonstrated the capabilities of FROG
- The first femtosecond pump probe spectroscopy was demonstrated successfully using malachite green in solution.

Lasers find their application in situations where non-contact measurement is critical and in particular, where complex problems cannot be solved with more conventional diagnostic techniques.



THE CSIR'S FEMTOSECOND SCIENCE LABORATORY HAS MADE HEADWAY IN MATCHING INTERNATIONAL ADVANCEMENTS IN THIS TECHNOLOGY

EMERGING RESEARCH AREA: NATIONAL NANOTECHNOLOGY CENTRE LAUNCHED

South Africa's first two national nanotechnology innovation centres were launched in November 2007 by the Minister of Science and Technology, Dr Mosibudi Mangena, at the CSIR in Pretoria.

The two centres were established at the CSIR and Mintek by the Department of Science and Technology (DST). Activities at these centres are aligned to the focus of the DST's Nanotechnology Strategy and each has its own research focus.

The focus of the CSIR centre, the National Centre for Nano-structured Materials, is on materials and energy research, while the centre at Mintek focuses on water and health. The diverse area of nanotechnology comprises the study and manipulation of tiny material structures with at least one dimension roughly between 1 and 100 nm. Over the past few years, nanotechnology has radically changed the fields of physical science and engineering and is extensive in its potential impact, which encompasses physics, chemistry, materials science and engineering, as well as biology and medicine.

Nanotechnology research leads to an unprecedented understanding of, and control over, the basic building blocks and properties of all natural and man-made objects. In addition, advances in nanofabrication, using top-down as well as bottom-up technologies, have afforded the ability to work at the atomic and molecular levels to create large structures with fundamentally new functionalities.

FAST FACT

Technical outputs of the CSIR's National Centre for Nano-structured Materials totalled eight internationally peer-reviewed articles, two articles published in international conference proceedings, one book chapter and nine keynote and plenary lectures. More articles and patents are pending. Among these are three feature articles on journal cover pages.

Minister of Science and Technology, Dr Mosibudi Mangena, at the launch of the nanotechnology centres, November 2007

"Theirs will not be blue sky research but one with identified, tangible measurables. They will have to be at the forefront, the tone-setters and catalysts of the country's research and development programme in nanotechnology."

EDUCATIONAL TELESCOPES TO STIMULATE LEARNERS' INTEREST

CSIR optronic engineers are developing a new educational telescope prototype kit to stimulate learners' interest in space science, engineering and technology. This follows a one-year contract between the Department of Science and Technology and the CSIR.

The newly-developed telescopes will be 100% South African and are intended to give as many South African learners as possible exposure to space science by ensuring that every school has such a telescope. The telescopes will be in kit form and have South African parts. Researchers are aiming for better image quality than existing systems by focusing on quality of materials in components and smart design. The CSIR is developing the telescopes as kits to be assembled by students and teachers before use while affording the user a clear understanding of the scientific components.

WORLD'S FIRST CRAFT AND DESIGN FABLAB ESTABLISHED

As part of its services to crafters in the province, the Cape Craft & Design Institute (CCDI) offers a state-of-the-art centre for innovation and FabLab (fabrication laboratory), assisting crafters in developing new products. In this way craft producers gain access to technology and resources that would previously not have been available to them. The centre encourages crafters in their innovation skills, as well as provides inspiration for new trends, applications and materials.

This first Craft & Design FabLab in the world significantly enhances local product competitiveness in global markets. The facilities at the centre include the high-tech FabLab, with design software linked to digital desktop manufacturing technology; a product development clinic for one-on-one product development support, with sources of inspiration and a net-search computer; and a resource centre for market information and documentation of indigenous knowledge and cultural heritage for inspiration.

The FabLab is visited by designers, design students and crafters and joint projects often result between the two groups.

Jim Chiota, master craftsman and a wire and bead artist, and Chris Jones, a design student of the Cape Peninsula University of Technology, developed a new torso-light, 'Dorothy', to the designs and cross-sections mapped out using the design software at a FabLab.

"This is manna from heaven," says Chiota. "It opens so many new avenues and ideas."

UNIQUE CSIR CASTING FACILITY UPGRADED

The investment casting facility of the CSIR has been upgraded to facilitate research on the casting of titanium alloys. An automated robotic shell mould-dipping line has been completed and is operational. Some fine adjustments to the programme are undertaken to compensate for various mould geometries.

This casting facility is unique in South Africa and positions the organisation for intensive, well-controlled and systematic research and development, particularly in shell systems. CSIR researchers are developing a titanium investment casting competency for South Africa.

The research is funded by the Department of Science and Technology's Advanced Manufacturing Strategy that is hosted by the CSIR. Novel technology to treat semi-solid metals to benefit the automotive and aerospace industries has been developed by the CSIR.
One of the ultimate research objectives of this project is to develop casting processes for aerospace components. An active working relationship exists between the CSIR and Boeing Phantom Works in the USA.

As part of the titanium investment casting technology chain, a state-of-the-art robotic dipping line has been installed for the manufacturing of the ceramic moulds. The moulds are used in the investment casting process.

MICROFLUIDICS – DISRUPTIVE TECHNOLOGY FOR THE FUTURE

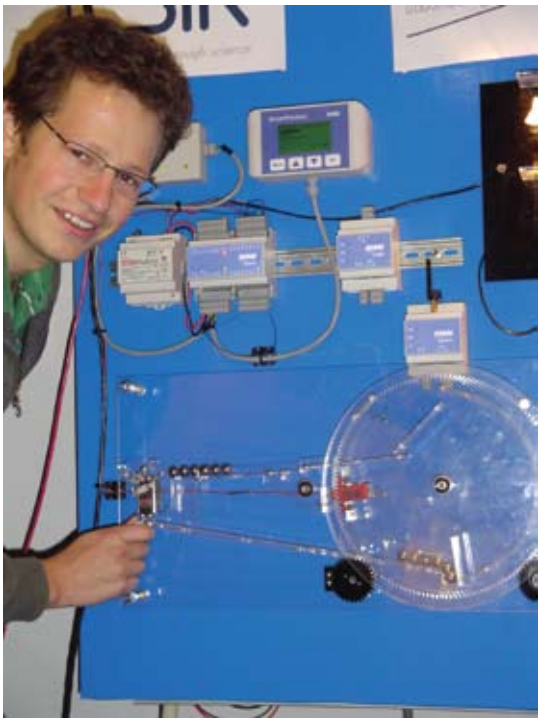
The advancement of micro-manufacturing technology has fuelled the development of microsystems for a wide range of electronic, biomedical and energy applications. The CSIR has taken the lead in South Africa in establishing the first micro-manufacturing laboratory to focus on the manufacture of micro-scale components.

Modelling and simulation are considered essential and indispensable tools for microfluidics research. Microfluidics is the science and engineering of fluids in very small volumes, typically in microscopic and nanoscopic ranges.

Fluids on these scales can be handled better while being controlled more precisely than in conventional fluidic systems. A multidisciplinary area, it combines different elements of physics, engineering, biology, chemistry and biotechnology with a wide range of applications spanning from manufacturing industries to diagnostic and therapeutic medical applications.

Micro-manufacturing research at the CSIR focuses on building competence in the design and manufacturing of microfluidic devices. Current work involves design and modelling of single, modular microfluidic elements and related manufacturing issues, such as machining, materials and sealing.

COMPUTING FOR ALL WITH 'THINNER CLIENT'



FAST FACT
The first installation of the Thinner Client system was completed at a school near the Soshanguve FabLab.

Empowering the community by giving them access to modern technology is at the core of a research project providing low-cost computing via existing infrastructure. This computing could be available to everyone, including people from traditionally-disadvantaged areas.

'Thinner Client', part of a series of projects in FabLab that is being developed for and by the community, will allow most households to have access to low-cost computing through the use of, for example, television sets, to display information. Thinner Client seeks to make internet infrastructure available at a FabLab accessible to the community around it. Instead of trying to rework the architecture of a PC, the Thinner Client architecture consists of simple terminal nodes that communicate to a more powerful central server situated at the FabLab. Potential owners of a Thinner Client can construct and program it in the FabLab themselves.

The project is funded by the Department of Science and Technology through its Advanced Manufacturing Technology Strategy, which is hosted by the CSIR.

PLEK PLAN BOOSTS CAPACITY

To stimulate and promote economic development, the CSIR has implemented a local economic development initiative, the PLEK Plan programme, in partnership with the Western Cape provincial government. The programme aims to fast-track the development of high quality capacity in rural municipalities to identify and validate high-impact economic opportunities.

There is a strong emphasis on skills development and transfer and 10 PLEK Plan managers stationed across the Western Cape are currently undergoing training in various aspects of business. This covers the practical aspects of identifying, investigating and qualifying opportunities and the preparation of business plans and investment proposals. In turn, managers are expected to transfer these skills to municipalities.

In 2007/08, PLEK Plan investigated several business prospects including niche opportunities in organic food, wine barrels, biodegradable packaging and bio-fuels.

CSIR facility to test for Snecma

The CSIR's mechanical testing laboratory has qualified to perform tests for the French aerospace company, Snecma Moteurs. This follows the successful testing of Snecma-supplied samples of Ti6Al4V (titanium) to the relevant test procedure.

The laboratory qualified to perform the Snecma procedure PRO-0430 for low-cycle fatigue testing under controlled stress or strain at room temperature. This kind of testing is a crucial step in the proper design and safety qualification of turbine disks used in commercial aircraft engines. The qualification also means that the CSIR is now part of an international research and development testing consortium created to ensure that these criteria are met.

SA-Hungary bilateral benefits CSIR

The CSIR has collaborated with the Budapest University of Technology and Economics (BME), Department of Physical Chemistry and Material Science, in Hungary, on polymer science. This forms part of the Hungarian-South African intergovernmental science and technology cooperation programme, which was awarded by the National Research Foundation for 2007 and 2008.

The CSIR's collaboration with Hungary has been beneficial to both institutions and instrumental in skills transfer in the fields of smart hydrogels, polymerisation and surface science. Plans are underway to extend the existing collaboration to a larger European Framework Programme in the field of stimuli-responsive materials for biological applications.

FAST FACT

Leading international aircraft manufacturer, Airbus, has signed a contract with the CSIR for collaborative research in the field of computational fluid dynamics. Aeronautics engineers from the CSIR will help with the development of mathematical software that is intended to aid the company as it designs and builds its next generation of aircraft, aiming towards 'greener, cleaner, quieter and smarter' means of travel. The contract positions South Africa to become a reckoned player in the field of hi-tech engineering and technology.

A Clean South Africa

A Clean South Africa

Innovative technology can aid industry

The year 2006 was marked by the publication of South Africa's second *Environment Outlook Report: A report on the state of the environment,* which spelt out a worsening in the overall state of the environment in South Africa and a declining Environmental Sustainability Index. This was evident in key pollution indicators, which showed evidence of decline or worsening since 1998:

Air quality in general	*Decreasing,* with high sulphur dioxide and particulate (PM10) levels
Health problems due to air pollution	*Increasing* at an estimated 20% over the next decade
Greenhouse gas emissions per person	*Disproportionately high* due to reliance on coal and high energy intensity of the economy
Health of river ecosystems	*Declining,* with effluent pollution continuing to grow

Analysis and opinion of trends

Driven by policies of economic growth, increasing industrialisation and urbanisation, combined with current levels of poor solid and liquid waste disposal practices, have impacted on the quality of South Africa's freshwater resources to the point where no further dilution capacity exists.

Influences and challenges

Pollution and waste research conducted by the CSIR over the past year, and focused around sustainable consumption and production; monitoring and analysis; society response; and technology intervention; has been in support of the vision of the White Paper on Integrated Pollution and Waste Management to "develop, implement and maintain an integrated pollution and waste management system, which contributes to sustainable development and a measurable improvement in the quality of life". The intention, through directed research, is to mitigate the impacts of waste generation through technology intervention and behavioural change, and provide the necessary evidence to support the creation of an enabling policy environment.

The following articles highlight some of the many research initiatives conducted within the CSIR over the past year, with a focus towards understanding the true cost of development on the environment; minimising waste generation; where waste cannot be eliminated, finding alternative methods for re-use or safe methods for treatment and disposal, encouraged through alternative policy instruments such as economic incentives or disincentives.


SAK
Gösser

A Clean South Africa

FOCUS ON CLEAN COAL TECHNOLOGIES FOR EFFICIENCY

CSIR research on clean coal technologies seeks to benefit the manufacturing industry while addressing the dwindling energy reserves and contributing to global sustainability.

The CSIR is actively involved in research into fluidised bed gasification (FBG), a clean coal technology that promises to be more efficient than conventional combustion, thereby reducing the amount of carbon dioxide and other pollutants released into the air from the production of electricity. FBG can also utilise lower grades of coal, thus extending South Africa's coal reserves and reducing the amount of 'discard' coal generated by coal beneficiation plants.

Current and medium-term research focus areas include bench-scale testing and analysis – selected coals are being subjected to standard coal analysis, such as proximate and ultimate analysis, and also petrographic analysis, as well as pilot-scale testing, which will be conducted on the fluidised bed gasifier located at the CSIR. The research has the potential to benefit the economy of South Africa considerably.

WATER AND MINE CLOSURE: MAKING DEVELOPMENT SUSTAINABLE

South Africa has a long history of an extractive economy based on mining. One of the most serious environmental impacts caused by mining is the deterioration in quality of both surface and ground water. A large number of mines have reached the end of their productive lives and are now left, often in a derelict and abandoned condition. A major problem is closed or abandoned mines that decant contaminated groundwater to surface, in places impacting on surface water quality.

CSIR researchers believe that if left unmanaged, this may have long-term impacts on the environment and on human well-being, and can trigger political and civil unrest. The South African Constitution states, among others, that 'everyone has the right to an environment that is not harmful to their health or wellbeing'. The Wonderfontein Spruit catchment is now spawning a series of political challenges that is likely to result in the very first test case to be brought before the Constitutional Court.

CSIR research into the historical and economic perspective of water, mining and waste in South Africa could give an insight into the true cost of mining where the social and environmental costs, typically externalised by mining houses, are borne by society decades after operation of the mine.

SEPARATED URINE HAS LONG-TERM POTENTIAL

While urine has long been viewed as waste, it has the potential to be seen as a renewable resource accounting for about 80% of the nitrogen, 50% of the phosphate and 70% of the potassium in domestic wastewater. These nutrients could potentially be recovered from urine if they were not diluted in the wastewater, a concept that has been advocated in Sweden since the 1990s.

If urine was collected at source – such as urinals – and treated separately, effluent quality could be improved drastically, reducing treatment costs and substituting our dependency on natural resources. While the technology has great potential in South Africa, CSIR researchers are still at the technology development phase, and have been focusing on modelling studies and working on a reactor design. The implementation of this technology requires a significant change in mindset towards waste, a change embraced by the municipality of Stellenbosch that has shown interest in a demonstration project as its wastewater treatment works are under pressure.

SEWAGE CAN DECONTAMINATE POLLUTED SOIL

CSIR scientists have shown that adding sewage sludge to petroleum-contaminated soil can result in improved remediation and in a cost-effective process, ascribed to the nutrients and carbon content of sewage sludge.

Management of sludge in an environmentally-responsible manner is a challenge facing municipalities because of the ever-increasing production of sludge. In a laboratory-scale study, CSIR researchers determined that adding sewage sludge, under different conditions, to petroleum-contaminated soil improved remediation activity. This was ascribed to the microbial population as well as to the additional carbon and nutrients present in sewage sludge.

This finding has environmental benefits since, when applied, the sludge is disposed of in an environmentally beneficial as well as a cost-effective manner – while simultaneously using a potential waste product beneficially. This principle is applied at some wastewater treatment plants in South Africa, where sewage sludge is used successfully as a fertiliser to cultivate 'instant lawn'.

This study proved again that waste should not be viewed as an unwanted product to be disposed of, but rather as a renewable resource with valuable usages.

FAST FACT

Superior enzyme for water purification

CSIR scientists have discovered a unique laccase that is superior to those used by commercial companies. The enzyme has shown excellent wastewater treatment capacity and bodes potential success in the treatment of wastewater on an industrial scale. Laccases are copper-containing oxidase enzymes found in many plants, fungi and microorganisms and are commonly applied in the textile dyeing/finishing, wine cork making industries and used for many other industrial, environmental, diagnostic and synthetic purposes. The studies may result in an alternative method of water purification for agricultural production.

CSIR EXPERTISE IMPORTANT PART OF DURBAN WASTE DISPOSAL MANAGEMENT

Internationally, there is growing concern over the inappropriate and indiscriminate disposal of wastes into the sea. Recent United Nations reports highlight the increasing presence of 'dead zones' in the marine environment, threatening the sustainability of human health, biodiversity, ecosystem functioning, fisheries and tourism in the coastal zone.

STRINGENT MONITORING AND MODELLING OF THE MARINE ENVIRONMENT OVER NEARLY FOUR DECADES HAS CLEARLY DEMONSTRATED A MASSIVE IMPROVEMENT IN SHORELINE CONDITIONS

In Durban, the CSIR has played a pivotal role, in partnership with eThekwini Municipality, in ensuring minimal impact on the marine environment from liquid wastes generated within the city. This was achieved by diverting the wastes from various shoreline outlets into two carefully-designed deep-sea outfalls extending some four kilometres off the Durban Bluff.

Stringent monitoring and modelling of the marine environment over nearly four decades has clearly demonstrated a massive improvement in shoreline conditions and no significant degradation of the offshore environment.

The current waste disposal strategy, when combined with source controls such as waste minimisation, appears to be appropriate and sustainable. The cleaner inshore environment, coupled with regular monitoring, allows the early detection and location of accidental or illegal discharges. This was an important factor in resolving the marine pollution episodes that arose in Durban early in 2008.

ECONOMICS OF WASTE MANAGEMENT

Currently, waste management policy in developing countries is dominated by 'command and control' regulation, which involves setting and enforcing waste management legislation and standards.

Environmental economists at the CSIR have started a research project on the viability of economic instruments for waste management in South Africa. In three subsequent reports on the matter, CSIR researchers focused instead on economic incentive-based instruments aimed at reducing the amount of waste generated and/or diverting waste from landfill to re-use or recycling; namely product and input taxes, quantity-based user fees, recycling subsidies and deposit-refund schemes.

The research aims to generate practical guidelines for waste management authorities at all three levels of government.

An economics perspective is also needed on other aspects of waste management, such as providing incentives for diverting waste from landfills to re-use and recycling initiatives; and providing incentives for the reuse or recycling of 'problem wastes' such as electronic waste, tyres or mining waste.

One of the main findings of the research to date has been that a number of fundamentals must be in place before sophisticated, first-world policy instruments can be introduced.

CLEANER PRODUCTION FOR SAVINGS AND GROWTH

Cleaner production (CP) technologies and services hold the key to saving billions of rand while stimulating economic growth in core South African industries. Established after the World Summit on Sustainable Development held in Johannesburg, and in its sixth year of existence, the National Cleaner Production Centre South Africa (NCPC-SA) demonstrates the value CP adds to industries in monetary terms, quality of life and balancing the scales to ensure sustainable consumption of natural resources.

Hosted by the CSIR and funded by the dti, the NCPC-SA is mainly involved in the priority sectors of agroprocessing, chemical, and clothing and textile industries. In these sectors, reductions in energy and resources have already followed on the introduction of CP technologies and services. The NCPC-SA will in future also focus on bringing about the same benefits in South Africa's mining industry. The centre actively advocates, establishes and strives to increasingly embed CP in South African industries.

CP is part of the preventative approach to address global pollution and resource consumption problems. It promotes the practice of sustainable production and consumption, such as:

- Use of services and related products that respond to basic needs and bring about a better quality of life
- Minimisation of the use of natural resources and toxic materials
- Minimisation of emissions of waste and pollutants over the life cycle so as not to jeopardise the needs of future generations.

A Digitally-inclusive South Africa

A Digitally-inclusive South Africa

ICT access for improved living

In 2003 South Africa, along with the rest of the world, signed the World Summit on the Information Society (WSIS) declaration of principles, which defines a common vision for a new kind of society in which "everyone can create, access, utilise and share information and knowledge, enabling individuals, communities and peoples to achieve their full potential in promoting their sustainable development and improving their quality of life"[3].

The outcomes associated with this vision of the information society include contributions to the eradication of extreme poverty and hunger; achievement of universal primary education; promotion of gender equality and empowerment of women; reduction of child mortality; improvement of maternal health; combating of HIV/Aids, malaria and other diseases; ensuring environmental sustainability; and partnerships for a more peaceful, just and prosperous world.

To realise this vision of a people-centred, inclusive and development-oriented information society, barriers to participation in the information society have to be addressed. Barriers to inclusion include language, illiteracy, lack of infrastructure, affordability and disability. Addressing these pose significant research challenges. In this regard the WSIS declaration also recognises the central role that science has played in the development of the information society. The information society is made possible through advances in information and communications technology (ICT) and the benefits associated with it.

The CSIR is therefore engaged in a comprehensive research and development (R&D) programme towards a digitally-inclusive South Africa with activities that can be grouped into a number of categories addressing different aspects:

- Extending the reach of ICT, which concerns R&D that promotes establishing affordable broadband access infrastructure
- Enabling the inclusive use of ICT, which concerns R&D aimed at addressing barriers to inclusive access such as language, literacy and disability
- Supporting national priorities through ICT, which concerns R&D on applications addressing specific needs such as health; education; small, medium and macro enterprises; and rural development
- Monitoring and evaluation of the use of ICT to promote adoption and to improve technology products and services.

Some of the research areas within this framework include open source, human language technologies, human/computer interaction, software development, remote sensing and wireless communication.

3 World Summit on the Information Society (WSIS) declaration of principles, Document WSIS-03/GENEVA/DOC/4-E. Geneva 12 December 2003 - Tunis 2005

A Digitally-inclusive South Africa

COMMUNITY USES DIGITAL DOORWAYS TO ACCESS INFORMATION

Computer literacy and associated skills are vital for South Africans to take their rightful place in the global information society. Through an innovative combination of technologies, inhabitants of Ntshongweni village near Durban have the opportunity to acquire computer literacy at their own pace and communicate with one another.

Five Digital Doorways have been installed at four schools – Wozamoya High, Albini Girls High and Ntshongweni and Lalelani primary schools – and at the community centre. This provides unrestricted access to computers for learners and adults, who are able to teach themselves how to use computers in an environment that is conducive to experimentation. A wireless mesh network adds another dynamic for this rural community as it allows community members to communicate *via* a chat programme. The Digital Doorway project is funded by the Department of Science and Technology and has to date deployed some 200 machines throughout South Africa.

Community member Khanyisile Lefleni (15):

"This will help me understand what is going on around me and keep me abreast of matters."

Community member Simiso Matiwane (44):

"The Digital Doorway means a lot to us. This community is hard hit by the scourge of poverty and this is going to help us access important government documents and we will also learn how to do business."

WIRELESS SOLUTIONS FOR REMOTE AREAS

People living in rural areas of developing and underdeveloped countries are not able to take advantage of the internet revolution, due to very little connectivity or no connectivity options. Wireless mesh networks have the potential to provide much needed broadband connectivity. However, studying the behaviour of such networks is a complex modelling problem.

A network needs to scale up from small, 10-device networks to large rural villages with hundreds or thousands of devices, and still ensure timely delivery of real-time data. The CSIR's wireless test bed has been used to expose the strengths and weakness of various routing protocols under different network conditions. This has provided new insights previously unavailable to the research community.

The most recent work is a detailed analysis of a protocol developed by a Berlin-based wireless mesh community, BATMAN (Better Approach to Mobile Adhoc Networking), by a visiting researcher, Elektra Aichele. Her work quantified BATMAN's advantages over existing mesh routing protocols.

ACCESS TO INFORMATION IN ALL OFFICIAL LANGUAGES

A range of government information and services is readily available in South Africa. Yet for many South Africans, the challenges presented by physical distance and having to use a language other than their mother tongue become obstacles to finding information and accessing services.

A telephone-based, speech-driven information system developed by the Meraka Institute of the CSIR aims to ensure that all people within South Africa's borders, particularly those with special needs, can access information about government services. The Lwazi project (meaning 'knowledge') is funded by the Department of Arts and Culture.

Given the relatively widespread penetration of telephony, the system promises easy information access to a very large user group, including a number of vulnerable populations. Users will interact with the automated system using either key presses or spoken phrases, automatically recognised by the system. It will be possible for the system to obtain and provide information dynamically, using text-to-speech systems to generate synthesised responses to questions. The fully-developed system will cater for all 11 official languages and will initially be piloted in the health and social development domain.

EMPOWERMENT THROUGH ONE4ALL PLATFORM

Millions of persons with disabilities remain excluded from the mainstream of society and the economy. The National Accessibility Portal initiative is a five-year research and development project that uses information and communications technology to contribute towards the empowerment and independent living of persons with disabilities, ensuring their participation and inclusion at all levels of society and the economy.

As part of this initiative, a technology framework titled One4All provides for accessible collaborative content management and dissemination. This generic framework allows organisations or groups to create an internet presence through collaborative content management and dissemination of information that is accessible to all, including persons with disabilities.

The framework is easy to use and accessible; in addition, it also supports multiple languages.

FAST FACT

Thibologa Sign Language Institution employs three hearing-disabled persons.

SIGN LANGUAGE FOR THE INFORMATION SOCIETY

According to the Central Statistical Service (SA Yearbook, 1998), four to five million South Africans have hearing impairments. Some 500 000 Deaf consider South African Sign Language (SASL) to be their first language and an estimated one-and-a half million South Africans use Sign Language to communicate. Currently, inappropriate support exists for Sign Languages on information systems.

Research at the CSIR on Sign Language at the South African Sign Language Laboratory looks at innovative ICT approaches to advance the use of Sign Language in the information society. The lab serves as a technical hub for Deaf technologies.

Current work focuses on enhancing the web experience for Sign Language users (accessibility), testing digital video technologies applied to sign languages (video for Sign Language) and the modelling and documentation of SASL using virtual avatars. The laboratory hosts the Thibologa Sign Language Institution, a start-up assisted by the Meraka Institute in technological support and market readiness. Thibologa offers online Sign Language training and interpretation services as well as introductory books and courses on Sign Language.

MODELLING A DOMAIN USING ONTOLOGIES

Finding meaningful information among millions of information resources on the worldwide web through manual perusal is a time-consuming and inexact process. By using technologies being developed for the Semantic Web, machines have access to the meaning of available information, which can be shared and processed by automated tools and human users. This includes the use of so-called ontologies.

An ontology structures information in ways that are appropriate for a specific domain. In doing so, it provides a way to attach meaning to the terms and relationships used to describe the domain. Researchers are investigating the use of ontologies as a means of providing improved data quality in the important bio-medical domain. An added benefit is the long-term relevance to a wider range of application domains.

HIGH-PERFORMANCE COMPUTING INFRASTRUCTURE POWERS GROWTH

High-end and scientific computing are becoming essential for progress in knowledge generation in areas ranging from finding cures for diseases through to designing better cars. It plays a central role in boosting the knowledge economy with important results in overall socio-economic growth.

Two major national interventions funded by the Department of Science and Technology and managed by the CSIR's Meraka Institute have significantly enhanced South Africa's ability to engage in this key area of 'cyberinfrastructure'. The first, the Centre for High Performance Computing (CHPC), was launched in May 2007, providing national supercomputing facilities and supporting relevant scientific computing research.

The second is the South African National Research Network (SANREN), connecting research institutions at high speeds. A significant milestone was achieved when the first research infrastructure sites went live in Gauteng in March 2008.

In addition, the CSIR hosts the C4, a supercomputing platform used as a research tool into the technologies of supercomputing and an enabler of computational science within the organisation and for the broader scientific community.

International partnerships with Intel, HP and IBM, through donations and co-investment in supercomputing facilities, assist in contributing to addressing Africa's challenges through a focus on applications in biomedical informatics and food security.

FAST FACT

The CSIR received a donation by IBM of a 14 teraflop Blue Gene/P system for Africa.

The CSIR's C4 has more than 100 registered scientific users.

SINGAZENZELA EMPOWERS THE YOUNG

While all children attempt to make sense of, interact with and influence their world, vulnerable children lack reliable and long-term support structures to give them empowering ideas and the space to use new information for their benefit.

The Singazenzela partnership comprising the CSIR, metaLAB, Glynis Clacherty and Associates, and HIVAN, has worked on a child-centric, systemic change initiative that will help young people become more resilient. It is based on an evolutionary open access and open standard platform accessible in a variety of media through any public network that reaches even the most marginalised communities.

The gaming approach helps children and young people grasp how best to make use of available resources. Children's values are translated into the five pillars of Singa (My World, My Game, My People, My Things and My Friend) to allow children to blend into one space various fragments of their existence. The aim is to build confidence and encourage children to initiate and manage relationships with public sector delivery agencies. An evolutionary prototype has been built at the Meraka Institute of the CSIR.

TEACHING PROGRAMMING THROUGH TANGIBLE OBJECTS

Many attempts have been made to give people of all ages access to computer programming, given the fact that a computer screen limits the human experience.

By using tangible learning objects, illetterate (unable to read or write yet) children are introduced to the topic of programming through broader experiences than those offered by the two-dimensional world of computer keyboard, mouse and screen. The GameBlocks programming environment consists of tangible input devices, low-cost and low-energy interpreting electronic circuitry, and tangible output devices. GameBlocks uses icons to represent the functionality of each cube. Recent research has extended GameBlocks to include hand-crafted, physical coding objects.

Manipulating physical objects to form a sequence of steps does not require the user to operate a computer; neither is the ability to read a prerequisite. It has been found that using physical syntax has the inherent benefit of eliminating syntax errors such as those encountered in most text-based or icon-based programming.

CSIR HELPS CREATE YOUNG ENGINEERS

South Africa needs to develop scientists, engineers and technologists to fill the gaps in the market needed to achieve a growing economy. National youth interventions are important to create sustainable pipelines to grow this skilled workforce.

The Meraka Institute of the CSIR has developed one such intervention, Young Engineers and Scientists of Africa (YESA), which begins at a preschool level and focuses on instilling a love of science and technology-related subjects through a broad range of hands-on activities.

To encourage creativity and innovation, YESA promotes constructive engagement of learners where information and communications technologies provide an enabling environment. Three streams cater for different age groups, TekkiTots (hands-on learning for preschoolers), TekkiKids (hands-on experiential learning for Grades 4-7) and FabKids (all grades). FabKids operates in the high-tech rapid-prototyping environment of FabLabs. The initial results of pilot studies in all three areas are very encouraging and confirm the importance of allowing children to be involved in their educational journey.

FAST FACT
Some 1 588 learners have participated in the YESA programme since April 2006, with nearly 18 000 contact hours reported.

MXIT PROVIDES MATHS SUPPORT FOR LEARNERS

Success in secondary school mathematics and science is cited as vital to growing the next generation of scientists and engineers.

More than four million school-going learners are subscribed to MXit, a popular instant-messaging service that is accessible *via* cell phone. To complement existing efforts to increase the pass rate for these subjects, the CSIR's Meraka Institute has devised 'Dr Maths', a novel mobile mathematics tutoring system, as an addition to its MobilED suite of services for teaching and learning *via* cell phones.

FAST FACT
More than 1 000 learners from around the country use Dr Maths.

Volunteer Dr Maths students from the University of Pretoria's engineering department use the PC-based MobilED mTutor client to give real-time mathematics homework support to learners. By using the MXit text-based chat facility these learners get help at a fraction of the cost of an SMS via a medium that is intuitive to them.

Learners access information via cell phones

Access to information resources is a requirement for school learners who must source information for educational purposes. Given infrastructural, financial and other constraints such as connectivity, this is a particular challenge for learners who live in rural environments.

Collaboration between the CSIR's Meraka Institute, the University of Pretoria and the Helsinki University of Art and Design, with funding from the Department of Science and Technology, has seen the development of the MobilED audio-wiki system. Through MobilED audio-wiki, learners and educators use cell phones, one of the most accessible and affordable computing devices in the developing world, to access information resources.

FAST FACT
UNICEF is using MobilEd audio-wiki as a platform for its work with children in Africa.

The platform allows them to send a text message with a search term to the service from a basic cell phone and then receive a call-back. Information from Wikipedia, the world's largest, collaboratively created online encyclopaedia, can be shared widely by connecting the cell phone to speakers. It is possible to fast forward and rewind the message to cater for varying levels of listening skills and comprehension. Learners can also dictate information to the service to add their unique knowledge to a subject.

Health hotline for Botswana HIV-caregivers

An extremely vulnerable sector of the population in Botswana is HIV+ babies and children (some are orphans) who are dependent on caregivers.

A partnership between the CSIR and the Botswana-Baylor Children's Clinical Center of Excellence has resulted in a health helpline to provide reliable medical information to these caregivers.

Through OpenPhone technology, an operational, fully automated, customised telephone-based system gives them access to relevant health topics in their home language, Setswana.

Two systems were evaluated to determine user preference: a touchtone system and an interactive voice recognition system. Medical information is provided by Baylor.

First Mile, First Inch project concludes

Low-cost communications requires a bottom-up, grassroots approach to innovation, which focuses on the end user and ensures sustainability.

As the coordinating partner in the First Mile, First Inch (FMFI) project, the CSIR's Meraka Institute worked with local organisations as well as organisations based in Angola, Mozambique and Zimbabwe. The project implemented a series of multidisciplinary projects based on low-cost communications in remote schools, clinics and telecentres throughout these countries.

It demonstrated how the first mile of connectivity in rural and marginalised communities could be bridged with WiFi and other off-the-shelf, self-taught technologies. The project addressed identified needs in the health and education sectors as well as information and connectivity gaps in all four participating countries. Partnerships with government, the private sector, international aid agencies and R&D technology organisations have been additional outcomes. A series of brochures for 'first mile' and 'first inch' implementation in a rural African context has been published.

Connectivity extends to Zambia

Some 450 million people in Africa do not have access to any form of connectivity. A memorandum of understanding between LinkNet Multi-Purpose Co-operative Society Limited of Zambia and the CSIR in August 2007 was a significant step towards the creation of low-cost, wireless connectivity in Africa.

LinkNet has as its objective to establish internet communication facilities in rural communities in Zambia to further holistic empowerment and capacity building of institutions and rural people. It has relied on the research and do-it-yourself mesh guide of the CSIR's Meraka Institute, which provides step-by-step instructions, to expand its activities.

Mesh networking is based on distributed infrastructure (wireless mesh nodes) that provides access to the network but also relays signals for other mesh nodes. Network coverage is extended with the addition of each new mesh node to an existing network. Mesh networks offer novel qualities like ease of deployment (it is wireless), self configuration (of new nodes) and self healing (when a node rejoins after temporary unavailability). The network can be extended by the community.

A Safe, secure and defensible South Africa


Conf deadline : 28 March

A Safe, secure and defensible South Africa

Defence capability seen as a national asset

South Africa's defence technology capabilities are unusually strong for a developing country of its size. Recently, this distributed capability has been seen as a national asset that can help our armed forces deployed extensively in peace support operations throughout the continent, bringing about stability. Other benefits brought about by world-class technology include the effective use of current and new military equipment; boosting the competitiveness of our aerospace and defence industry and therefore our export earnings; furthering international collaboration; supporting our fight against and prevention of crime; and growing advanced, leading-edge technical and management skills.

To achieve these goals, our political leaders have proposed that state-owned defence science and technology (S&T) be consolidated into a single national entity: the SADERI or South African Defence and Evaluation Research Institute.

The CSIR is actively supporting the above goals and intentions of government. The primary role of defence S&T is to support the armed forces with their main missions and tasks now and in the future.

Internationally, the approach of governments and industry to defence research and development (R&D) is constantly adjusting to the nature of their security situation, their international objectives, national and regional development goals and the industrial outlook. Defence and security are a major tool of domestic and foreign policy.

With the changing nature of conflict, security threats are seen to be moving away from the classic nation-state threats to ones driven by broad issues that affect development, stability and matters of personal security. The application of armed forces are being turned towards resolving intra-state conflict, restoring law and order in failed states, intervening in conflicts over resources, in ethnic unrest, organised crime, terrorism and helping in rescue efforts such as those resulting from natural disasters. The role of national defence forces are increasingly seen as helping to bring about order, building peace, removing dangerous threats and acting as a deterrent to armed threats.

Technology trends have been influenced by and are influencing the way these changing priorities and roles are approached. Looking at the global technology environment over the past few decades, the most significant trends have been associated with the pace with which commercial industries have developed and commercialised advanced technologies – a 'democratisation of advanced technology', indeed.

Whereas defence applications used to set a large part of the agenda in global technology development, this is no longer the case. Industry sectors such as automotive, communications and electronics are outspending defence in terms of R&D investment on material, component and device technologies.

This has had a number of consequences. Firstly, defence R&D and innovation have moved towards new ground. It now deals more with issues of high systems-level integration of commercially-available technologies in more capable, adaptive and multi-role systems.

The second consequence is that powerful commercial technologies are now easily available to groups and individuals on an unrestricted commercial basis. This allows the technically astute to develop simple but highly effective weapons that can and have been used with devastating effect to stop or disrupt major armed forces. The increasingly closer integration of military and commercial technology extends to cyberspace as well where threats to defence and major national infrastructure can now originate from almost anywhere. This has meant that defence equipment has become increasingly complex to develop, acquire, maintain and operate. Ongoing technology advances will likely increase automation in future and reduce complexity to the user and operator.

Utilising and building on its current base, South African and specifically the CSIR's efforts in defence technology are driven by government's defence position and by other national objectives in the areas of national security, industrial development and competitiveness and the growth of advanced technical skills.

Considering these objectives, some of the areas we are focusing on are:

- Autonomous, unmanned air and ground vehicles
- Advanced sensor systems and signal processing for surveillance, identification and environmental characterisation

- Modelling and simulation environments and tools allowing exploration of emergent behaviour of integrated systems and, increasingly, including the human as part of the system
- Important aerospace technologies
- Information, protection, sustainment and weapon systems supporting armed force members
- Putting our range of capabilities to work in areas where it will contribute to crime fighting and prevention and help us achieve our vision of a safe and secure South Africa.

With the active support of our key stakeholders, the departments of Defence and of Science and Technology, strategic partners in industry and universities, international colleagues in academia, national laboratories and industry; the CSIR is determined to stay at the leading edge and make a significant impact and contribution to the national objectives in defence, security and development.

A Safe, secure and defensible South Africa

SUPPORTING THE ESTABLISHMENT OF A NATIONAL BORDER CONTROL CENTRE

The CSIR's safety and security technologists are working closely with the inter-departmental border control operational coordinating committee on the establishment of a National Border Management Coordination Centre (NBMCC). The South African Revenue Service is the lead agency.

The NBMCC is to become a central, inter-departmental hub that will facilitate operational coordination, real-time information flow and dissemination. It will support coordinated management of South Africa's borders with a specific focus on improving efficiency and security at ports of entry. The project delivered a conceptual design, which, after formal acceptance by the coordinating committee, will be used as the basis for establishing the NBMCC. The NBMCC needs to be substantially in place for the Confederation Cup in 2009, and fully functional for the FIFA Soccer World Cup in 2010. The project included a comprehensive study of communications, reconnaissance and surveillance sensors and technologies currently deployed on air, land and maritime borders.

ACTION FOR A SAFE SOUTH AFRICA

The CSIR Crime Prevention Group has over a period of several years synthesised research done in a range of South African environments, both by the research group itself, and many others to develop a model for breaking the cycle of crime and violence in South Africa. The CSIR model incorporates findings from other science councils, universities, civil society organisations and practitioners. Using this model, Action for a Safe South Africa (AFSSA) is a coalition of many of these contributing organisations. AFSSA also includes the International Marketing Council for South Africa, the Gordon Institute for Business Science, the Da Vinci Institute for Technology Management, the African National Congress and government, as well as others committed to the goal of a safe South Africa. A convention with the intention of drafting a national plan for a safe South Africa is planned for August 2008.

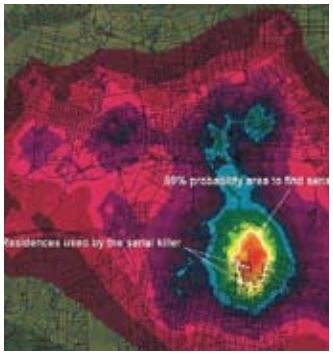
CSIR MAPPING FIGHTS CRIME

Crime mapping is used at strategic, operational and tactical levels to combat crime. Strategically, it is used to deploy police resources effectively. Hot spot analysis and target performance maps are examples of operational purposes. The CSIR has also developed crime clocks, which give a picture of the distribution of crime by time of day and/or day of week.

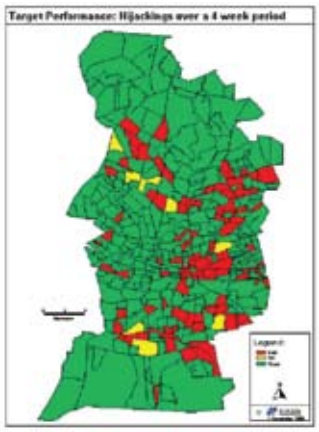
At a tactical level, mapping is used in investigations and prosecutions. Investigators can build an understanding of the offender's *modus operandi* such as suburb preference, time of day of incidents and time lag between incidents.

Geographic profiling is the most widely-used tool to perform tactical crime mapping. Crime theories such as journey-to-crime, rational choice theory and mental maps are utilised. Possible anchor points from which offenders will commit serial crimes, ranging from rape and murder to house break-ins, are determined.

The CSIR has extended geographic profiling with cell phone data to determine possible routes, time of criminal activity and criminal activity space. Cell phone data provide the place of use, time of transactions, and information on the other party participating in the transaction.



GEOGRAPHIC PROFILING IS THE MOST WIDELY-USED TOOL TO PERFORM TACTICAL CRIME MAPPING



UNDERSTANDING AERODYNAMIC CONTROL SYSTEMS OF MODERN FIGHTER AIRCRAFT

A sound knowledge base is required on flying qualities to evaluate and test modern fighter aircraft such as the Gripen that is controlled by computer systems (fly-by-wire systems) – as opposed to the mechanical control systems of conventional aircraft.

Since aircraft such as the Gripen are essentially controlled by a computer system, the flying (handling) qualities experienced by the pilot are principally dependent on the software. This means that flying qualities can change as improvements are made to the software throughout the operational lifetime of the aircraft. For the South African Air Force (SAAF) to extract the maximum operational performance and efficiency from its new Gripen aircraft, the flying qualities have to be evaluated continuously and verified in its own tactical environment.

The CSIR has been instrumental in a number of initiatives, including developing a customised reference specification for Gripen; supporting the SAAF during its acceptance test and evaluation programme; undertaking a series of research flying qualities tests to familiarise test pilots with new flight test techniques; researching technical topics where current knowledge is incomplete; and developing advanced software for flying qualities data analysis.

UNMANNED AERIAL VEHICLE TECHNICAL DEMONSTRATOR DEVELOPED

As part of the quest to build unmanned aerial vehicles (UAVs) that will fly longer and further through improved aerodynamic efficiency, researchers at the CSIR and Stellenbosch University successfully designed and built a new UAV, dubbed 'Sekwa'.

The use of unmanned aircraft first gained ground in military domains, before the potential benefits for civil applications became evident, including support during natural disasters, powerline and oil pipe inspections or border patrol.

Sekwa resulted from one of four CSIR projects on technologies for unmanned aerial systems and was aimed at the development of a small blended-wing-body UAV with in-flight adjustable stability. The UAV serves as a platform to develop advanced aerodynamic shape optimisation methods and to evaluate the possible aerodynamic advantages that relaxed stability may have on flying wing type configurations. CSIR researchers developed and manufactured the airframe using mathematical optimisation throughout the development process. Electronic systems experts at Stellenbosch University developed the control system.

Sekwa has been flight tested in a stable configuration with a conventional radio control system. The control system has also been tested in a hardware-in-the-loop environment.

FAST FACT

The Sekwa project resulted in two MSc degrees, several conference papers, and a further six MSc students will be involved in follow-on research.

FIELD TRIAL DATA AID RESEARCH ON RADAR DETECTION

In the quest to develop a surveillance system to assist South Africa in curbing weapons trafficking, smuggling, poaching, piracy, illegal immigration and terrorism, CSIR researchers undertook a series of radar measurement field trials, using its various home-grown measurement facilities.

For the development of a persistent, ubiquitous surveillance system that will provide unprecedented situational awareness, it is crucial to verify initial modelling and simulation results with actual measured data – hence the field trials.

While entities of interest range from small recreational watercraft to large cargo and tanker ships, significant research effort was directed at the detection of small boats, which is particularly difficult due to the often comparable magnitude of the boat and sea surface radar return (small boats are often shadowed by the sea waves).

The project continues, with researchers attempting to model the radar reflectivity characteristics of sea waves under all environmental conditions, as well as reflectivity characteristics of different classes of small vessels in the South African maritime area. The shared data from these trials are proving to be invaluable to the international network of research aimed at developing different detection and tracking techniques.

EVALUATING THE NEW NAVY FRIGATES' RADAR SYSTEM

The CSIR evaluated the effectiveness of the electronic counter-countermeasures (ECCMs) of the optical radar tracker (ORT) on South Africa's new Navy Frigates. The ORT is a key component of the Frigate's defensive systems against attack from incoming missiles and aircraft. A recent strike on a warship off the Syrian coast by a shore-launched missile demonstrated the vulnerability of such Navy assets when operating close to the shore, typical of what would be required when the Frigates are employed to support African peace operations.

The CSIR undertook the project using the knowledge and test infrastructure (Enigma) built up at the CSIR over a 15-year period. The Enigma system is a radar stimulator able to capture a radar pulse, modify it and play it back to the radar, thus emulating various aircraft movements as well as typically employed ECCMs. Tests were conducted at the Simon's Town Naval Base and results were analysed to evaluate ECCM effectiveness and consequently direct research pertaining to the optical radar tracker. This has demonstrated the value of having local capability to perform tests too sensitive to outsource.

PROTECTING HUMANS AGAINST BLAST INJURIES

CSIR biomedical engineers are determining exactly how people are injured during explosive events in order to develop improved personal protection. From a medical perspective, understanding the injury mechanisms of explosive events can aid in the treatment of the victim.

In one of the studies, the findings on the gruesome killing of six herd-boys during a single blast 10 years ago, appeared in the *South African Medical Journal*. The deadly blast occurred accidentally when the boys were playing with an unexploded grenade. The grenade in question, an M26, is designed to harm through high-velocity fragments that it expels, resulting in mutilation of the body. Given the close proximity of the children to the grenade, the severity of their injuries might have been increased by the heat and overpressure caused by the explosion.

The study was undertaken in collaboration with the forensic medicine department of the Walter Sisulu University. The knowledge generated in this field is helping engineers design improved protection systems that may ultimately save lives.

HIGH SPEED EQUIPMENT HELPS CHARACTERISE EXPLOSION EVENTS

Development and evaluation of explosive protection systems require an understanding of all events and phenomena, from the explosive detonation initiation to the blast loading effects. Due to the extremely short duration inherent to explosion events, the research to gain the required understanding must be supported by specialised ultra high-speed event-recording equipment and methods.

Research tools and techniques include ultra high-speed and high-speed photography, flash x-ray, ultra high-speed data acquisition of pressure, strain, acceleration and velocity. The CSIR uses high-speed photography, providing a unique opportunity to visually record and analyse the behaviour and interaction of fast moving objects and events that would otherwise be invisible to the human eye.

It also assists in capturing blast wave formation, propagation and interaction with structures enabling the blast loading process to be better understood. In addition, it enables terminal ballistics such as explosively-formed penetration mechanics to be researched and understood, providing the opportunities to devise counter-measures and more effective protection solutions.

The frame-by-frame account of the interaction between the explosive and the hull provides detailed information that is unobtainable after the event. This information can be used to characterise and validate landmine and surrogate explosions.

CSIR PARTICIPATES IN OPERATION GREEN POINT

The CSIR took part in an intensive defence, peace, safety and security interoperability exercise in preparation for the 2010 Soccer World Cup.

The exercise, Operation Green Point, was a joint exercise between the CSIR, the South African Police Service, the South African National Defence Force (SANDF), other government departments, security agencies, institutes and local industry partners.

The South African government is dedicated to guaranteeing safety and security for the entire event. The operation was considered to be an excellent training opportunity for security personnel to be deployed during major events. The security of, for example, the airspace above and around a stadium during the World Cup, is of paramount importance.

The aim of the exercise was to investigate doctrine and interoperability within a joint and interdepartmental command and control environment. The CSIR provided the modelling and simulation support to address this interoperability.

SIMULATION TOOL IMPROVES SITUATIONAL AWARENESS

A new simulation, visualisation and analysis tool has been developed by the CSIR. Dubbed 'Cyclops 2', the new 3D analysis tool can connect either to a running simulation or read logged simulation output data. The user can move around in time, for example, pause the simulation or step backwards and forwards. All simulation objects and events are displayed in a 3D view and the user can move around freely in this virtual world to inspect the spatial and temporal relationships between objects.

Any information not directly observable in reality – such as a radar's detection dome and a missile's field of view cone – may also be added. A filter allows the user to selectively exclude certain objects or groups of objects to unclutter the 3D view.

Cyclops2 has been used successfully in support of ground-based air defence systems acquisition decision support. It has also been used to visualise the effectiveness of infrared countermeasures during one-on-one shoulder-launched missiles.

CSIR SUPPORTS ACCIDENT INVESTIGATION FOR THE ARMY

A board of inquiry was set up after a tragic accident during a live fire exercise of the air defence artillery at the Lohatla combat training centre.

Gun number 124 – a 35 mm MK 5 anti-aircraft – rotated uncontrollably to the left and fired without the operator's control, claiming the lives of nine members of the SANDF, seriously injuring 13, while two escaped with minor injuries.

A CSIR expert was appointed as chairperson of the technical committee comprising the SANDF, Armscor, industry and academic staff.

The committee looked into the technical aspects of the accident. Research included mechanical studies; safety, metallurgical and ergonomic analyses. The findings were tested in a laboratory and on the actual equipment to prove accuracy.

The technical committee completed the investigation in two weeks, providing findings and recommendations to the board of inquiry. The findings were accepted without reservations.

CSIR gives support after Mozambique blast

CSIR engineers served on the joint board of inquiry set up by the South African National Defence Force (SANDF) to render technical support after an explosion occurred in an ammunition storage facility of the Forças armadas de Defesa de Moçambique (FADM), located northwest of Maputo.

The joint board of inquiry was established to investigate the cause of the accident and to recommend corrective actions to prevent a re-occurrence. The explosion resulted in severe loss of life and mutilation among the local population who resided near the facility.

The Mozambique government approached South Africa for humanitarian assistance and an SANDF task team was deployed to Maputo. This team rendered tactical explosive ordnance disposal support to the FADM in operations to clear the affected areas from unexploded munitions. The unexploded munitions and pieces of munitions were collected in the affected area and transferred to a demolition site at Moamba, 60 km west of Maputo.

FAST FACT

Countering landmine threats:

As part of its technology transfer efforts, the CSIR presented a mine awareness course to members of the South African Police Service (SAPS) prior to its deployment to southern Angola last year to counter the mine threat in that area. The deadly legacy of wars and conflicts causes death and mutilation through buried landmines and unexploded ordnance. The SAPS Task Force and Explosive Unit extended its operation to locate and destroy illegal weapons and ammunition from Mozambique to other southern African countries, such as Angola.

New shores for device that captures and repeats radar frequency signals

During the past year, the CSIR has added German and American laboratories to the list of users of its digital radio frequency memories (DRFMs).

DRFMs are the main building blocks of hardware-in-the-loop, radar target and electronic countermeasure simulators. The radar signals are digitally delayed and Doppler-shifted to simulate high-fidelity scenarios of realistic, moving targets and jamming techniques.

Typically, buying countries – which in the past also included Finland, France, the United Kingdom and Australia – use the systems for acceptance testing, evaluation of operational radars, radar research and development (R&D) and training and doctrine development.

The technology, developed at the CSIR, resulted in international opportunities to present courses on DRFMs and to collaborate on joint R&D programmes with leading laboratories.

The technology has, among others, been used to upgrade the South African Air Force's Oryx radar jammer and to evaluate the sensors on the South African Navy's new Frigates.

Virtual scenarios aid peace support in Africa

The SANDF is responsible for enabling stability in Africa, making peace support and counter-terror operations on the continent a necessity. Training soldiers for these missions is difficult, due to the variety and infrequency of scenarios. To boot, training is limited to relatively unrealistic scenarios that, for example, do not include live fire.

With significant advances in computer soldier-games in terms of realism, accuracy and multi-player capability, the CSIR, through its expertise in modelling and simulation, was able to develop a soldier scenario that very closely resembles the reality of peace support and counter-terror in Africa. Numerous improvements have been made following feedback from the SANDF, resulting in simulations used for training and operational preparedness of South African missions to uplift the continent.

Towards an Energy-secure South Africa

Towards an Energy-secure South Africa

Energy challenges facing South Africa

South Africa faces major challenges in the supply, distribution and consumption of energy, as well as dealing with the emissions from burning fossil fuels.

The security of energy supply, in general, has received top priority due to recent electricity outages and the escalating prices of hydrocarbon fuels. The post-apartheid era has seen very little supply capacity added to the South African energy mix. The consequence has been aging infrastructure that struggles to cope with a growing economy. Installing new infrastructure requires long lead time. The envisaged economic growth, as well as strategies and plans to alleviate poverty, are subsequently hampered.

In terms of distribution, many communities still lack access to modern energy. Universal access to modern energy sources has not yet been achieved, with between 27 and 30% of the South African society, mostly rural, remote and dispersed communities, not yet having access to modern energy.

The intensity of the energy used is a further concern. South Africa still attracts energy-intensive economic activities due to perceived low energy prices. Further, the low prices invariably lead to inefficient use of energy, and provide little incentives to invest in energy-efficient technologies.

Emissions from burning fossil fuels remain a major challenge. While South Africa is only the 30th largest economy, it is the world's 12th largest carbon emitter. Much of the carbon is associated with coal for electricity generation (more than 80%) and liquid fuel production (over 30%). The coal consumption is projected to grow well into the future. This has potential ramifications in terms of the country's international standing; no emission reduction obligations have been set under the Kyoto protocol, but this status could change in the post-Kyoto future. An increasing international awareness of the carbon footprints of products is a further concern for South African exports.

These challenges beckon research and development into alternative energy value chains to assess, demonstrate and identify the most sustainable options in the South African context. Still in the early stages, the CSIR plays a role in three intervention areas:

Clean and cleaner energy solutions

These solutions include options to reduce carbon emissions such as the use of renewables, e.g. concentrated solar thermal power; the hydrogen economy, e.g. through thermo chemistry; and recycling of materials such as aluminium and glass. Carbon-neutral options include energy beneficiation, e.g. biogas and synfuels from municipal sewage. Carbon-lean technologies are another cleaner energy solution, e.g. clean coal technologies.

Distributed and co-production value chains

The shortening of construction lead times, improving efficiencies, better utilisation of traditional biomass, stimulation of local economic activities, and facilitating better municipal service delivery, are directed at distributed and co-production value chains in off-grid regions of the country, as opposed to centralised energy generation/production and distribution.

Energy-efficient technologies

These include the use of electricity from industrial waste heat, i.e. the so-called organic Rankine cycles; zero energy in commercial buildings; and energy efficient construction for disadvantaged communities.

Towards an Energy-secure South Africa

RURAL GRID ELECTRIFICATION INVESTIGATED

Access to modern energy services contributes to better rural livelihoods and provides, among other benefits, better education and healthcare. For these reasons, governments of many developing countries have dedicated rural electrification programmes.

Professor Ian Jandrell, internationally-renowned scientist, and Head of the School of Electrical and Information Engineering at the University of the Witwatersrand (Wits)

"My interaction has been one the best experiences I have had in terms of collaboration. The staff members managing the laser rental pool programme are genuinely interested in the results. We view them as partners; it's a winning partnership and I'm absolutely thrilled about working with the CSIR National Laser Centre."

Christien Strydom, Director at the North-West University's School of Physical and Chemical Sciences

"There is no way that I would be able to do this work without the CSIR National Laser Centre. The rental pool programme has given me the opportunity to do this ground-breaking research and I am very impressed with the assistance that the CSIR provides."

With this in mind, the CSIR investigated the energy policies and different strategies for rural grid electrification in four Southern African Development Community (SADC) countries – Botswana, Namibia, South Africa and Zimbabwe. The study was funded by the South African National Energy Research Institute (SANERI). The aim of the regional comparison was to identify lessons from each country. The study showed significant policy shortcomings existed partly due to lack of capacity in the SADC region to develop and maintain relevant and up-to-date policies. It also suggested that targeting productive activities common in rural areas – such as agroprocessing, metal fabrication, repairs, and services – would be more effective in transforming rural livelihoods.

Merely extending the grid to rural households has resulted in limited use of electricity (and continued reliance on firewood) due to affordability constraints. South Africa needs to have a more aggressive small enterprise-focused component in its rural electrification programme.

CARBON CAPTURE AND SEQUESTRATION STUDIED

Without swift and drastic reduction measures, greenhouse gas (GHG) emissions signify disaster for life on earth.

Emission reductions are quantified as the prevention of one tonne of carbon dioxide (CO_2) gas equivalent emitted in a developing country. CO_2 capture and sequestration (CCS) is a possible GHG mitigating strategy. The conventional understanding is that CO_2 would be compressed and transported for storage in geological formations, pumping into the ocean, land storage in biomass or as mineral carbonates, or for use in industrial processes.

The CSIR is currently researching the maturity of CCS technologies and projects; the applicability of CCS as a GHG-reducing technology; and the potential of CCS in southern Africa.

Although the potential for CCS in South Africa has been noted due to major point sources, the cost of capture and storage is a major obstacle and the geological storage options are problematic for South Africa and neighbouring countries due to large transport distances. Consequently, financial incentives, such as the Clean Development Mechanism of the Kyoto Protocol, are unlikely to benefit the implementation of CCS projects in southern Africa in the near future.

FAST FACT

Current focus areas of the fuel cell research group at the CSIR are:

- **Development of the anode and cathode electro-catalysts for direct alcohol fuel cells (DAFC) and screening of the electro-catalysts using electrochemical methods (such as cyclic voltammetry and chronoamperometry)**
- **Structural characterisation of the selected electro-catalyst (composition, particle size and surface area)**
- **Investigating methods of preparing membrane electrode assembly and examining the structural properties and impedance studies**
- **Development of membranes and catalysts for alkaline DAFC application**
- **A hybrid micro fuel cell for powering of portable electronics (0 W–10 W)**
- **Testing of a prototype stack.**

FUEL CELLS TO BE AN ENERGY RESOURCE

Fuel cells are a promising technology for use as a source of heat and electricity in buildings, and as an electrical power source for vehicles.

Fuel cell research at the CSIR focuses on direct alcohol fuel cells, particularly ethanol and methanol micro fuel cells, including hydrogen proton exchange membrane fuel cells. Research is conducted into membrane development, synthesis and characterisation of catalysts, assembly and testing of membrane electrode assembly (MEA). Synthesis of combinatorial catalysts uses physical and electrochemical methods, like the electrochemical atomic layer deposition/epitaxy.

Fuel cell research is a multidisciplinary field and requires expertise in chemistry, engineering and material science, all of which are available at the CSIR, as well as capabilities found at other institutes.

Fuel cells generate electric power from an electrochemical process using fuels such as hydrogen or methanol. Compared with batteries, fuel cells typically have a higher energy density and a lower weight. In addition, fuel cells are environmentally friendly (especially if the fuel is taken from a renewable resource) and can be recharged instantly. Fuel cells are being used in prototype applications to power vehicles, cell phones, homes, commercial properties, laptops, household appliances and industrial machinery.

LASER SCIENCE USED IN FUEL TECHNOLOGY RESEARCH

Laser scientists at the CSIR and chemists of the North-West University (NWU) have started a research project in which they are using femtosecond laser pulses to investigate chemical processes of importance to a South African energy company. Using this new technology could result in far lesser amounts of waste or by-products.

FAST FACT
Besides at the CSIR, femtochemistry has not been done elsewhere in Africa.

The short duration of femtosecond laser pulses allows the study of the motions of atoms and electrons.

The project involves a literature survey, certain modifications to the existing femtosecond laboratory at the CSIR, feasibility studies and recommendations for the application of femtochemistry and laser spectroscopy in fuel-producing technology.

It complements the university's signing of a cooperation agreement with an industrial partner for research into nuclear engineering using femtochemistry. The CSIR has been subcontracted by the NWU in a R1,7 million agreement.

ALGAL BIODIESEL – A WORTHY SUCCESSOR TO FOSSIL FUELS?

Many people may regard algae as a worthless inconvenience clinging to the structures of water features. Yet modern-day science is proving that there may be more to these autotrophic organisms than meets the eye.

The CSIR embarked on a three-year project to investigate algae as an alternative energy source for Africa. Science has shown that indigenous algal strains are capable of producing high levels of biodiesel-related lipids. The objective of this research is to investigate applied biotechnology options for the enhancement of lipid production through organism movement, development of knowledge of the metabolic enhancement of lipid production and the integration of competitive processes into existing carbon challenges, such as flue gas generated as emissions in electricity production, and the growth of algae on industrial and domestic effluent systems.

The Durban University of Technology is a collaborative partner on this project, which promises new knowledge and a potential competitive advantage for the local manufacture of biodiesel.

CSIR AND SANERI JOIN FORCES IN CLEAN COAL TECHNOLOGY

The CSIR and the South African National Energy Research Institute (SANERI) have joined forces to further research and development in the field of clean coal technology through signing a co-funding agreement. The CSIR aims to champion the development and promotion of capability in this priority research field.

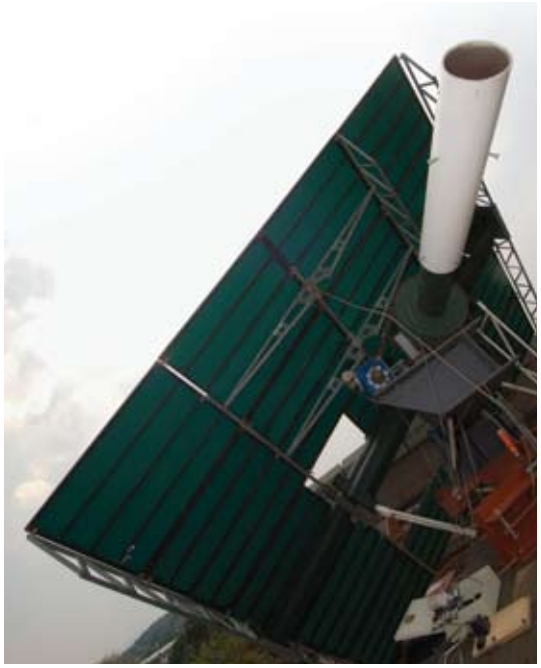
Coal is the most important energy resource in South Africa, with 71% of our primary energy and 88% of electricity being derived from coal. Due to the small reserves of oil and gas and the high cost of electricity derived from renewable energy resources such as wind and solar, it is expected that coal will remain the most important energy source for at least the next 75 years.

Coal gasification is regarded as the most likely technology to replace conventional coal combustion for power generation in the 21st century. With coal gasification, power station efficiencies can be improved from the current 35% to 45–55%. The emissions of CO_2 into the atmosphere can also be reduced by capture and storage.

ENERGY FROM CONCENTRATED SUNSHINE

A new CSIR research project is aimed at generating electricity from concentrated sunshine. A 25 m^2 target-aligned heliostat has been developed at the CSIR, using low-cost components and simple systems. This is in response to the national priority of providing access to electricity for all South Africans by 2012.

Many villages still not connected to the national electricity grid are small and far from the grid and the economics of extending the grid cannot be justified. The project aims to solve the remote rural power question through the development of a solar gas turbine system running on concentrated solar energy when available, and stored solar thermal heat or fossil fuel during cloud cover or at night.



MID-TERM ENERGY SOLUTION POSSIBLE

The CSIR has identified a suite of four South African coals as possible fuels for power stations that would operate for three or four decades, towards the middle of this century, to alleviate the growing energy demand.

The electricity demand in South Africa is increasing at a rate of 1 000 MW per year. While increasing pressure exists to adopt non-fossil fuel electricity-generating technologies, the abundant reserves and low cost of coal make it the preferred energy source to meet increasing demands for the foreseeable future. It is also anticipated that coal generation is likely to meet 80–90% of this demand.

FAST FACT
CCTs are defined as technologies designed to enhance both the efficiency and the environmental acceptability of coal extraction, preparation and use.

The challenge is to enhance both the efficiency and environmental acceptability of coal use by adopting clean coal technologies (CCTs).

In a research study into the gasification characteristics of South African power station coals, the CSIR has identified the integrated gasification combined cycle (IGCC) as a potential CCT that could be applied to achieve low CO_2 emission initially and ultimately get near-zero emissions of greenhouse gases, which is likely to be a requirement for electricity producers towards the middle of the 21st century.

The IGCC also holds the advantage of reduced water consumption and the potential for co-production of liquid and gaseous fuels and chemicals.

CSIR outcomes

Technology transfer

Internationally, the Bayh-Dole Act of 1980 (USA) helped to establish the field of technology transfer in respect of publicly-financed research. Since then, many countries have moved to establish similar legislation and it is increasingly recognised that technology transfer activities should not be driven by potential revenues only, but also by a strong focus on ensuring public good outcomes.

Intellectual property (IP) that is managed appropriately offers wide-ranging opportunities for the economy and society. Such IP provides knowledge that results in technological developments, stimulates technology transfer, promotes investment and revenue, fosters R&D for further technology development, and provides solutions to socio-economic needs.

Within the context of the CSIR, technology transfer refers broadly to both the movement and dissemination of IP and associated technologies from the CSIR to sites of use, and issues concerning the end users' ultimate acceptance and use of the IP and associated technology. It is therefore vital that these are transferred successfully and used in a manner that benefits the economy and society. It is only then that the IP and its associated technologies become real innovation and their impact realised.

During the past financial year, the CSIR has had several technology transfer successes. A selection is highlighted on the following pages.

ART OF MAKING HOSPITALS SAFER

To develop a better understanding of the dynamics of airborne infection, such as in the case of tuberculosis (TB), the CSIR has entered into a joint venture with the South African Medical Research Council, the American Centres for Disease Control and Prevention and the Harvard School of Public Health. In the first phase, infected air from hospital wards occupied by drug-resistant TB patients was extracted and tested to evaluate the infectiousness and potential for spread through a hospital.

The Airborne Infection Research facility, attached to the Witbank TB Hospital in Mpumalanga, provides excellent laboratory conditions to study elusive aspects of airborne infection. Combining microbiology with architectural engineering effects a better understanding of how infectious airborne diseases are spread and finds ways to prevent that spread. The project has already spawned new thinking in terms of design for long-term care facilities and future developments in building and construction standards.

HIGH QUALITY SOLUTION FOR UPGRADING TOWNSHIP ROADS

The CSIR, in collaboration with the University of Pretoria and the Cement and Concrete Institute, has developed a cost-effective solution for the upgrading of unsurfaced township roads. A durable thin concrete overlay was designed for residential and access roads with low to medium-traffic loading conditions. Apart from giving communities surfaced roads, it is a low maintenance, cost-effective pavement, which will be using a waste product for aggregate.

The biggest advantage is that this high quality product uses labour-intensive construction methods. The skills obtained by the labour force can be applied successfully in other building projects, leading to sustainable job creation. In partnership with the Gauteng Department of Public Transport, Roads and Works and the City of Tshwane, 20 township roads in Mamelodi, Soshanguve and Atteridgeville are currently being upgraded.

HERBAL REMEDIES YIELD NEW THERAPEUTICS FOR HIV

Scientists at the CSIR have investigated herbal botanical extracts prepared from plants representing South Africa's rich biodiversity in a bid to source affordable therapies for the treatment of HIV-infected patients. Three medicinal plants identified for more detailed scientific research were shown to have promising efficacy and toxicity in carefully controlled *in vitro* models of HIV infection. This intellectual property was subsequently licensed to Arvir Technologies, a private start-up biotechnology enterprise funded by LIFElab, for further development. Arvir has been studying the botanical extracts and aims to develop the identified active ingredients as novel antiretrovirals for the treatment of HIV-infected patients in South Africa.

IRMA UNLOCKS RURAL ACCESS AND MEETS MOBILITY CHALLENGES

The CSIR, in collaboration with the Mpumalanga Department of Roads and Transport, piloted an integrated rural mobility and access (IRMA) project in the Albert Luthuli Municipality. IRMA addresses mobility and accessibility constraints imposed by the remoteness, spatial dispersion and often lack of adequate infrastructure in rural areas. These inhibit development and constrain rural communities' access to services and socio-economic opportunities.

Technology interventions include the provision of appropriate and integrated rural transportation infrastructure (including pedestrian bridges, paths and low-level crossings), services complete with adequate funding streams for maintenance and development, and all-weather road and footpath access to socio-economic facilities such as schools, clinics, shops and government offices. Labour-based technologies are utilised in the construction and implementation of interventions, bringing direct income to immediate beneficiaries and equipping locals with life skills.

INFOPRENEURS DEVELOP SOCIAL ENTERPRISES

The inTouch Africa® software system, which has been trademarked by the CSIR, enables the decentralised creation, maintenance, distribution and presentation of trading (details of individuals and institutions) and catalogue-type information (promotional information) that enhances the supplier/customer interaction in a supply chain. Unlike web-based systems, inTouch Africa® stores information at the point of use. The 'toolbox' component focuses on enhancing the various components of service delivery in 'walk-in' support facilities and satellite centres, supporting entrepreneurs and citizens in social enterprise development. The appropriate use of information and communications technology is an effective means to encourage social enterprise development. Current users of this software include the Umsobomvu Youth Fund and Red Door Network in the Western Cape as well as selected Kellogg Foundation 'zoom sites' in southern Africa and the Botswana Technology Centre.

CASH-IN-TRANSIT TECHNOLOGY EXTENDED

The CSIR has extended its technology in cash-in-transit vehicles. The new package, already transferred to a local company in Olifantsfontein, is based on the Nissan UD60 chassis and drive train. The new package was developed as a higher performance product relative to the previous model (based on the Nissan UD40) in terms of speed and load-carrying capacity for the local and export markets.

LANDMINE PROTECTION TECHNOLOGY DEVELOPED FOR VEHICLES

The CSIR-developed wheeled and tracked vehicle landmine protection technology against anti-tank blast landmines was derived from the landmine protection soldier boot technology, developed for the United States Army. An American company licensed the technology, which is in the form of a special insert attached to the rims of military vehicles that channels the shock wave associated with a landmine explosion away from the vehicle. In so doing, it minimises the effect of the explosion on the vehicle and its occupants.

CSIR outputs

CSIR research publications available online at http://researchspace.csir.co.za/dspace

The speed of progress in science is linked to the efficiency with which scientists communicate their research results to their peers and lay persons, resulting in the implementation of such results in new technologies and practices[4].

For centuries the communication chain was very slow, compared to today's standards. However, the past decade has brought dramatic changes to the overall scientific communication process in terms of information distribution and retrieval.

FAST FACT

CSIR information services specialists serve on the Boards of the National Library of South Africa and the South African National Library and Information Consortium.

In conjunction, the open access movement has gathered momentum and the CSIR, wishing to actively support this initiative, launched an institutional repository in August 2007. The manner in which this repository is integrated with the organisation's web site is unique in South Africa and rare in the international community. Where copyright allows, items featured on the following pages may be retrieved, in full text, from http://researchspace.csir.co.za/dspace. The repository has already proven to be valuable to the broader research community with close to 9 000 articles downloaded between August 2007 and March 2008.

The international research community is acknowledging the contribution the CSIR's open access research outputs make to the global knowledge pool. As a result, representatives from CSIR Information Services were invited to co-facilitate an institutional repository development workshop for counterparts from developing countries in Malaysia. Furthermore, the CSIR has joined the WorldWideScience Alliance and is also contributing its article metadata to some 200 harvesting services, ensuring that CSIR research contributes to the progress of science and the overall improvement of life for mankind.

The following pages list research published in 2007.

4 Björk, B-C, 2007, A model of scientific communication as a global distributed information system. Available: http://informationr.net/ir/12-2/paper307.html

A

Abbott GR, McDuling JJ, Parsons SA, Schoeman JC. 2007. Building condition assessment: a performance evaluation tool towards sustainable asset management. *CIB World Building Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007.*

Abdul Gaffar MY, Nel WAJ. 2007. Investigating the effect of a target's time-varying Doppler generating axis of rotation on ISAR image distortion. *RADAR 2007: IET International Conference on Radar Systems, Edinburgh, United Kingdom, 15-18 October 2007.*

Akhter R, Ivanchev LH, Burger HP. 2007. Effect of pre/post T6 heat treatment on the mechanical properties of laser welded SSM cast A356 aluminium alloy. *Materials Science and Engineering A*, 447(1-2), p.192-196.

Alexander P, Van Loggerenberg J, Lotriet H, Phahlamohlaka J. 2007. The use of the Repertory Grid for collaboration and reflection in a research context. *Group Decision and Negotiation (GDN) 2007, Montreal, Canada, 14-17 May 2007.*

Amis MA, Rouget M, Balmford A, Thuiller W, Kleynhans CJ, Day DJC, Nel JL. 2007. Predicting freshwater habitat integrity using land-use surrogates. *Water SA*, 33(2), p.215-222.

Amod S, Wall K. 2007. The SAICE infrastructure report card. *71st Institute of Municipal Engineering of Southern Africa (IMESA) Conference: Sustainable Municipal Engineering 2010 and Beyond, Durban, South Africa, 23-26 October 2007.*

Ampofo-Anti N. 2007. Highlighting the gap between critical outcomes requirements and built environment education in South Africa. *2nd Built Environment Conference, Port Elizabeth, South Africa, 17-19 June 2007.*

Anandjiwala RD, Hunter L, Kozlowski R, Zaikov G (eds.). 2007. *Textiles for Sustainable Development*, 419pp.

Archer M, De Vos BJ, Visser MS. 2007. Preparation, essay and certification of aqueous ethanol reference solutions. *Accreditation and Quality Assurance*, 12(3-4), p.188-193.

Archibald SA, Scholes RJ. 2007. Leaf green-up in a semi-arid African savanna: separating tree and grass responses to environmental cues. *Journal of Vegetation Science*, 18(4), p.583-594.

Arendse CJ, Malgas GF, Scriba MR, Cummings FR, Knoesen D. 2007. Effect of deposition pressure on the morphology and structural properties of carbon nanotubes synthesized by hot-filament chemical vapor deposition. *Journal of Nanoscience and Nanotechnology*, 7(10), p.3638-3642.

Ashton PJ. 2007. Riverine biodiversity conservation in South Africa: current situation and future prospects. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 17(5), p.441-445.

Ashton PJ. 2007. The role of good governance in sustainable development: implications for integrated water resource management in South Africa. In: Turton AR, Hattingh HJ, Maree GA, Roux DJ, Claassen M, Strydom WF (eds.). *Governance as a Trialogue: Government-Society-Science in Transition*, p.77-100.

B

Bachoo A, Archibald SA. 2007. Influence of using date-specific values when extracting phenological metrics from 8-day composite NDVI data. *International Workshop on the Analysis of Multi-temporal Remote Sensing Images at the Multitemp 2007 IEEE Conference, Leuven,Belgium, 18-20 July 2007.*

Badenhorst JAC, Davel MH. 2007. The effect of speech rate variation on acoustic phone stability in Afrikaans speech recognition. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Bandyopadhyay J, Ray SS, Bousmina M. 2007. Effect of organoclay on the orientation and thermal properties of liquid-crystalline polymers. *Macromolecular Chemistry and Physics*, 208(18), p.1979-1991.

Bandyopadhyay J, Ray SS, Bousmina M. 2007. Thermal and thermo-mechanical properties of poly(ethylene terephthalate) nanocomposites. *Journal of Industrial and Engineering Chemistry*, 13(4), p.614-623.

Beck SL, Fossey A. 2007. Gamma irradiation induces sterility or seedlessness in black wattle (*Acacia mearnsii*). *Seed Science and Technology*, 35(2), p.351-359.

Berger DK, Crampton BG, Hein I, Vos W. 2007. Screening of cDNA libraries on glass slide microarrays. In: Rampal JB (ed.). *Microarrays. Vol 2, Applications and Data Analysis*, p.177-203.

Biermann SM. 2007. Improving the location of low income housing delivery in South African urban areas. *10th International Computers in Urban Planning and Urban Management Conference, Iguassu Falls, Brazil, 11-13 July 2007.*

Biggs R, Scholes RJ. 2007. Assessing the loss of natural capital: a biodiversity intactness index. In: Aranson J, Milton SJ, Blignaut N (eds.). *Restoring Natural Capital: Science, Business and Practice*, p.44-54.

Biggs RO, Scholes RJ, Ten Brink BJE, Vackar D. 2007. Biodiversity indicators. In: Hak T, Moldan B, Dahl AL (eds.). *Measuring Progress Towards Sustainability: Assessment of Indicators*, p.249-270.

Biliouris D, Verstraeten WW, Dutre P, Van Aardt JAN, Muys B, Coppin P. 2007. A compact laboratory spectro-goniometer (CLabSpeG) to assess the BRDF of materials: presentation, calibration and implementation on *Fagus sylvatica* L. leaves. *Sensors*, 7, p.1846-1870.

Binedell ML, Brownlie S. 2007. Limits of acceptable change: how much is too much? In: Govender K, Adouin M (eds.). *Enhancing the Effectiveness of SEA in South Africa*, p.55-74.

Bollig C, Forbes A, Dlamini TJ. 2007. Photonics in South Africa. *Nature Photonics*, 1(12), p.673-675.

Booth R, Meyer T. 2007. On the dynamics of total preorders: revising abstract interval orders. *9th European Conference on Symbolic and Quantitative Approaches to Reasoning with Uncertainty (ECSQARU 2007), Hammamet, Tunisia, 31 October - 2 November 2007.*

Botha A, Ford M, Aucamp FN, Sutinen E. 2007. MobilED: mobile technology access for Africa. *IADIS International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2007), Algarve, Portugal, 7-9 December 2007.*

Botha A, Cronje JC, Ford M. 2007. Up close and very personal: a proposed conceptual framework for mobile technology as a participant. *IST-Africa 2007 Conference, Maputo, Mozambique, 9-11 May 2007.*

Botha AF, Hunter L. 2007. The effect of coarse edge on wool spinning performance and yarn properties. *South African Journal of Science*, 103(3/4), p.174-176.

Botha AF, Hunter L. 2007. The effect of coarse edge on worsted spinning performance and yarn properties. In: Anandjiwala RD, Hunter L, Kozlowski R, Zaikov G (eds.). *Textiles for Sustainable Development*, p.147-159.

Botha GR, Barnard E. 2007. Factors that affect the accuracy of text-based language identification. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Botha GR, Zimu VZ, Barnard E. 2007. Text-based language identification for the South African languages. *SAIEE Africa Research Journal*, 98(4), p.141-146.

Botha LR, Van Heerden SP, Prinsloo FJ. 2007. Picosecond mid-infrared amplifier for high average power. *XVI International Symposium on Gas Flow, Chemical Lasers and High-Power Lasers, Gmunden, Austria, 4-8 August 2006.*

Brent AC, Rogers DEC, Ramabitsa-Siimane TSM, Rohwer MB. 2007. Application of the analytical hierarchy process to establish health care waste management systems that minimise infection risks in developing countries. *European Journal of Operational Research*, 181, p.403-424.

Brent AC, Petrick W. 2007. Environmental impact assessment during project execution phases: towards a stage-gate project management model for the raw materials processing industry of the energy sector. *Impact Assessment and Project Appraisal*, 25(2), p.111-122.

Brent AC, Premraj S. 2007. Environmental management systems in the automotive supply chain in South Africa: a pilot study. *South African Journal of Industrial Engineering*, 18(2), p.21-34.

Brent AC, Labuschagne C. 2007. Sustainability assessment criteria for projects and technologies: judgements of industry managers. *South African Journal of Industrial Engineering*, 18(1), p.19-33.

Brent AC, Van Erck RPG, Labuschagne C. 2007. Sustainability cost accounting. Part 2, A case study in the South African process industry. *South African Journal of Industrial Engineering*, 18(1), p.1-17.

Brent AC, Pretorius MW. 2007. Sustainable development: a conceptual framework for the technology management field of knowledge and a departure for further research. *16th International Conference on Management of Technology, Miami Beach, Florida, U.S.A., 13-17 May 2007.*

Brink AVZ, Roberts MKC. 2007. Early warning and/or continuous risk assessment of rockfalls in deep South African mines. *4th International Seminar on Deep and High Stress Mining, Perth, Australia, 7-9 November 2007.*

Brits J, Botha GHK, Herselman ME. 2007. Conceptual framework for modeling business capabilities. *InSite Conference, Ljubljana, Slovenia, 22-25 June 2007.*

Burger L, Forbes A. 2007. A model of the transverse modes of stable and unstable porro-prism resonators using symmetry considerations. *Laser Beam Shaping VIII, San Diego, California, U.S.A., 28-29 August 2007.*

Butgereit LL. 2007. Math on MXit: the medium is the message. *13th Annual National Congress of the Association for Mathematics Education of South Africa (AMESA), White River, South Africa, 2-6 July 2007.*

Butgereit LL. 2007. Using open source software contributions in an internship program. *IST-Africa Conference, Mozambique, 9-11 May 2007.*

Byaruhanga YB, Erasmus C, Taylor JRN, Emmambux MN. 2007. Effect of heating cast kafirin films on their functional properties. *Journal of the Science of Food and Agriculture*, 87, p.167-175.

C

Cairncross EK, John J, Zunckel M. 2007. A novel air pollution index based on the relative risk of daily mortality associated with short-term exposure to common air pollutants. *Atmospheric Environment*, 41(38), p.8442-8454.

Chakwizira J. 2007. The question of road traffic congestion and de-congestion in the Greater Johannesburg area: some perspectives. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Chapman RA, Du Toit J, Haldenwang BB, Hichert T, Van Vuuren E. 2007. The natural/physical environment. In: Roux A (ed.). *Business Futures 2007*, p.5.1-5.153.

Charyulu DV, Sivakumar V, Bencherif H, Narayano Rao D. 2007. Rayleigh LiDAR investigation of stratospheric sudden warming over a low latitude station, Gadanki (13.5°N; 79.2°E): a statistical study. *SPIE Optics and Photonics 2007: Lidar Remote Sensing for Environmental Monitoring VIII, San Diego, California, U.S.A., 26-30 August 2007.*

Cilliers JE, Smit JC. 2007. On the effects of quantization on mismatched pulse compression filters designed using L-p norm minimization techniques. *RADAR 2007: IET International Conference on Radar Systems, Edinburgh, United Kingdom, 15-18 October 2007.*

Cilliers JE, Smit JC. 2007. Pulse compression sidelobe reduction by minimization of Lp-norms. *IEEE Transactions on Aerospace and Electronic Systems*, 43(3), p.1238-1247.

Cobbing J, O'Dochartaigh BE. 2007. Hydrofracturing water boreholes in hard rock aquifers in Scotland. *Quarterly Journal of Engineering Geology and Hydrogeology*, 40, p.181-186.

Coetzee L, Govender N, Viviers MI. 2007. The National Accessibility Portal: an accessible information sharing portal for the South African disability sector. *International Cross-Disciplinary Conference on Web Accessibility, Banff, Canada, 7-8 May 2007.*

Colvin CA. 2007. Expanding concepts within eco-hydrology to accommodate the hydrodiversity of groundwater dependent ecosystems (or How do aquifers make ecosystems lazy, inefficient and vulnerable?). *XXXV International Association of Hydrogeologists Congress: Groundwater and Ecosystems, Lisbon, Portugal, 17-21 September 2007.*

Combrinck L, Fourie CJS, Combrinck A. 2007. Earth-tide and crustal motion displacement: a comparison between modelling and two measured techniques. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Conradie DCU, Gibberd JT, Mentz F, Ras H. 2007. Towards a continuum of computational building simulation tools to support the design and evaluation of complex built environments. *CIB World Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007.*

Cooper AK, Moellering H, Duren U, Hjelmager J, Huet M, Rapant P, Rajabifard A, Laurent D, Iwaniak A, Abad P, Martynenko A. 2007. An initial model of the computation viewpoint for a spatial data infrastructure. *ICC 2007: 23rd International Cartographic Conference: Cartography for Everyone and for You, Moscow, Russia, 4-10 August 2007.*

Crampton MC, Berger E, Reid VS, Louw ME. 2007. The development of a flagellin surface display expression system in the gram-positive bacterium, *Bacillus halodurans* Alk36. *Applied Microbiology and Biotechnology*, 75(3), p.599-607.

D

Dabrowski J, Ashton PJ, Murray K, Leaner JJ, Mason RP. 2007. Anthropogenic mercury emissions in South Africa: coal combustion. In: Zhu Y, Lepp N, Naidu R (eds.). *Biogeochemistry of Trace Elements: Environmental Protection, Remediation and Human Health.*

Davel M, Barnard E. 2007. Effort and accuracy during language resource generation: a pronunciation prediction case study. *SAIEE Africa Research Journal*, 98(4), p.124-128.

De Beer M, Sadzik E. 2007. Comparison of contact stresses of the test tyres used by the one third scale model mobile load simulator (MMLS3) and the full-scale test tyres of the heavy vehicle simulator (HVS): a summary. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

De Lange WJ, Kleynhans TE. 2007. Towards more inclusive long-term bulk water resource management. *Agrekon*, 46(3), p.371-397.

De Waal AJ, Ritchey T. 2007. Combining morphological analysis and Bayesian networks for strategic decision support. *ORiON: Journal of the Operational Research Society of South Africa*, 23(2), p.105-121.

De Waal AJ, Barnard E, Du Preez E. 2007. Topic models applied to multilingual data. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Delalieux S, Van Aardt J, Keulemans W, Schrevens E, Jonckheere I, Coppin P. 2007. Detection of biotic stress (*Venturia inaequalis*) in apple trees using hyperspectral data: non-parametric statistical approaches and physiological implications. *European Journal of Agronomy*, 27, p.130-143.

Denneman E, Verhaeghe BMJA. 2007. Aggregate packing characteristics of good and poor performing asphalt mixes. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Denneman E. 2007. The application of locally developed pavement temperature prediction algorithms in performance grade (PG) binder selection. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Dholakia K, Lee WM, Paterson L, MacDonald MP, McDonald R, Andreev I, Mthunzi P, Brown CTA,Marchington RF, Riches AC. 2007. Optical separation of cells on potential energy landscapes: enhancement with dielectric tagging. *IEEE Journal of Selected Topics in Quantum Electronics*, 13(6), p.1646-1654.

Dlodlo N, Hunter L, Cele CD, Metelerkamp RGM, Botha AF. 2007. A hybrid expert systems architecture for yarn fault diagnosis. *Fibers and Textiles in Eastern Europe*, 15(2), p.43-49

Dlodlo N, Hunter L, Cele CD, Metelerkamp RGM, Botha AF. 2007. Integrating an object-oriented approach and rule-based reasoning in the design of a fabric fault advisory expert system. *Fibers and Textiles in Eastern Europe*, 15(3), p.68-73.

Du Plessis A, Rohwer EG, Steenkamp CM. 2007. Investigation of four carbon monoxide isotopomers in natural abundance by laser-induced fluorescence in a supersonic jet. *Journal of Molecular Spectroscopy*, 243(2), p.124-133.

Du Plessis EM, Theron J, Berger E, Louw ME. 2007. Evaluation of *Staphylococcus aureus* class C non-specific acid phosphatase (SapS) as a reporter for gene expression and protein secretion in Gram-negative and Gram-positive bacteria. *Applied and Environmental Microbiology*, 73(22), p.7232-7239.

Du Plessis L, Kohler E. 2007. Heavy vehicle simulator testing on pre-cast concrete panels. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Du Preez WB, Corderley G. 2007. Strategic opportunities and challenges for composites R&D in South Africa: a CSIR perspective. *Fibre Reinforced Composites Conference, Port Elizabeth, South Africa, 9-12 December 2007.*

Durrheim RJ. 2007. Agulhas bank, Witwatersrand basin and Limpopo belt deep reflection seismic profiles and geoscience transects. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Durrheim RJ. 2007. Broadband seismological investigations of the crust and mantle beneath Southern Africa. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Durrheim RJ, Labrie D. 2007. Data-driven simulation of the rock mass response to mining. Part 1, Laboratory experiments using Nepean sandstone models. In: Potvin Y, Hadjigeorgiou J, Stacey D (eds.). *Challenges in Deep and High Stress Mining*, p.293-304.

Durrheim RJ, Labrie D. 2007. Data-driven simulation of the rock mass response to mining. Part 2, Numerical modelling of the "Room and Pillar" experiment. In: Potvin Y, Hadjigeorgiou J, Stacey D (eds.). *Challenges in Deep and High Stress Mining*, p.305-313.

Durrheim RJ. 2007. The DeepMine and FutureMine research programmes: knowledge and technology for deep gold mining in South Africa. In: Potvin Y, Hadjigeorgiou J, Stacey D (eds.). *Challenges in Deep and High Stress Mining*, p.131-141.

Durrheim RJ, Cichowicz A, Ebrahim-Trollope R, Essrich F, Goldbach OD, Linzer LM, Spottiswoode SM, Stankiewicz T. 2007. Guidelines, standards and best practice for seismic hazard assessment and rockburst risk management in South African mines. *4th International Seminar on Deep and High Stress Mining, Perth, Australia, 7-9 November 2007.*

Durrheim RJ, Anderson RL, Cichowicz A, Ebrahim-Trollope R, Hubert G, Kijko A, McGarr A, Ortlepp WD, Van der Merwe N. 2007. The risks to miners, mines and the public posed by large seismic events in the gold mining districts of South Africa. In: Potvin Y, Hadjigeorgiou J, Stacey D (eds.). *Challenges in Deep and High Stress Mining*, p.33-40.

Duvenhage B, Delport JP, Louis AL. 2007. A 3D visual analysis tool in support of the SANDF's growing ground based air defence simulation capability. *African Graphics Association Conference, Grahamstown, South Africa, 29-31 October 2007.*

Duvenhage B, Nel JJ. 2007. Inaccuracies when mixing coordinate reference frameworks in a system of systems simulation. *IEEE Africon 2007, Windhoek, Namibia, 26-28 September 2007.*

Duvenhage B, Kourie DG. 2007. Migrating to a real-time distributed parallel simulator architecture. *Summer Computer Simulation Conference (SCSC 2007): Moving Towards the Unified Simulation Approach, San Diego, California (USA), 15-18 July 2007.*

Duvenhage B, Le Roux WH. 2007. A peer-to-peer simulation architecture. *The 2007 High Performance Computing & Simulation (HPCS'07) Conference, Prague, Czech Republic, 4-6 June 2007.*

Dye PJ, Versfeld D. 2007. Managing the hydrological impacts of South African plantation forests: an overview. *Forest Ecology and Management*, 251(1-2), p.121-128.

E

Eatwell KA, Verryn SD, Roux CZ. 2007. Investigation of the occurrence of instability or collinearity in selections made in a series of E. grandis progeny trials in South Africa. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Egoh B, Rouget M, Reyers B, Knight AT, Cowling RM, Van Jaarsveld AS, Welz A. 2007. Integrating ecosystem services into conservation assessments: a review. *Ecological Economics*, 63(4), p.714-721.

Engelbrecht AD, North BC, Hadley TD. 2007. Investigation into the gasification characteristics of SA power station coals. *24th Annual International Pittsburgh Coal Conference, Sandton, Johannesburg, South Africa, 10-14 September 2007.*

F

Fernandes M, Manuel A, De Koning CB, Perry CB, Pelly SC. 2007. 1-[3-(1H-Indol-2-yl)-2-furyl] ethanone. *Acta Crystallographica Section E: Structure Reports Online*, E63, p.o4695-o4696.

Fleming GJ, Van Der Merwe MR, Mcferren GA. 2007. Fuzzy expert systems and GIS for cholera health risk prediction in southern Africa. *Environmental Modelling & Software*, 22(4), p.442-448.

Forbes A, Botha LR, Du Preez N, Drake T. 2007. Influence of laser parameters on laser ultrasonic efficiency. *XVI International Symposium on Gas Flow, Chemical Lasers, and High-Power Lasers, Austria, 4-8 August 2006.*

Ford M, Batchelor J. 2007. From zero to hero: is the mobile phone a viable learning tool for Africa? *3rd International Conference on Social and Organizational Informatics and Cybernetics (SOIC 2007), Orlando, U.S.A., 12-15 July 2007.*

Ford M, Botha A. 2007. MobilED: an accessible mobile learning platform for Africa? *IST-Africa 2007 Conference, Maputo, Mozambique, 9-11 May 2007.*

Fossey A. 2007. Bioethics in agricultural research and research management. In: Loebenstein G, Thottapilly G (eds.). *Agricultural Research Management*, p.121-147.

Fossey A, Mathura S, Beck SL. 2007. Effect of leaf and tree age on chlorophyll content in diploid black wattle (*Acacia mearnsii*). *Southern Hemisphere Forestry Journal*, 23, p.21-26.

Fossey A. 2007. Epigenetics: beyond genes. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Fourie CJS, Van Schoor AM, Mare LP, Kruger D, Du Plessis SJ. 2007. The evaluation of new age materials for use in geophysical scale model construction and possible use in geophysical instrumentation. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Fourie CJS, Combrinck L, Croukamp L, Saunders I. 2007. Geotechnical and tropospheric site investigation for a proposed space geodesy observatory near Matjiesfontein in the Great Karoo. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Franz RM. 2007. Guide to best practice for hearing protection devices. *Occupational Health Southern Africa*, 13(5), p.3-9.

Franz RM. 2007. Noise. In: Stanton DW, Kielblock J, Schoeman JJ, Johnston JR (eds.). *Handbook on Mine Occupational Hygiene Measurements*, p.183-200.

Frost PE, Scholes RJ. 2007. The advanced fire information system. In: Nicklin S, Cornwell B, Dodd J, Griffiths J (eds.). *The Full Picture*, p.168-169.

Frost PE, Annegarn H. 2007. Providing satellite-based early warnings of fires to reduce fire flashovers on South Africa's transmission lines. *IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2007), Barcelona, Spain, 23-28 July 2007.*

Funke NS, Oelofse SHH, Hattingh J, Ashton PJ, Turton AR. 2007. IWRM in developing countries: lessons from the Mhlatuze catchment in South Africa. *Physics and Chemistry of the Earth*, 32(15-18), p.1237-1245.

Funke NS, Nortje K, Findlater KM, Burns MER, Turton A, Weaver AV, Hattingh J. 2007. Redressing inequality: South Africa's new water policy. *Environment*, 49(3), p.10-23.

Funke NS. 2007. To the benefit of the few and the chagrin of the many: South African water management practices under colonial and apartheid rule. *5th International Water History Association Conference, Tampere, Finland, 13-17 June 2007.*

G

Gammon DW, Kinfe HH, De Vos DE, Jacobs PA, Sels BF. 2007. A new procedure for highly regio- and stereoselective iodoacetoxylation of protected glycals and α-1,2-cyclopropanated sugars. *Journal of Carbohydrate Chemistry*, 26(3), p.141-157.

Gazendam AD, Eksteen JJ, Jones L. 2007. On the establishment of infrastructure for the South African National Centre for High Performance Computing. *IEEE Africon 2007, Windhoek, Namibia, 26-28 September 2007.*

Gerber AJ, Van Der Merwe A, Alberts R. 2007. Practical implications of rapid development methodologies. *Computer Science and Information Technology Education Conference (CSITEd 2007), Mauritius, 16-18 November 2007.*

Gerber AJ, Barnard A, Van Der Merwe AJ. 2007. Towards a semantic web layered architecture. *International Conference on Software Engineering, Innsbruck, Austria, 13-15 February 2007.*

Gibberd JT, Mphutlane LG. 2007. School infrastructure performance indicator system (SIPIS). *CIB World Building Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007.*

Gibberd JT, Sebake S. 2007. Side stepping poor infrastructure: enabling environments in developing countries. *CIB World Building Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007.*

Godfrey LK. 2007. Ecosystem governance and the trialogue debate: an overview of the trialogue relationship and the engagement along interfaces. In: Turton AR, Hattingh HJ, Maree GA, Roux DJ, Claassen M, Strydom WF (eds.). *Governance as a Trialogue: Government-Society-Science in Transition,* p.319-336.

Goliger AMW. 2007. Severe wind phenomena in Southern Africa and the related damage. *Journal of Wind Engineering and Industrial Aerodynamics Special Issue*, 95(9-11), p.1065-1078.

Goliger AMW. 2007. South African wind loading specifications: the Euro way? *Journal of Wind Engineering and Industrial Aerodynamics Special Issue*, 95(9-11), p.1053-1064.

Goss H, Coetzee MJ. 2007. Capacity building for integrated development: considerations from practice in South Africa. *Town and Regional Planning*, 51, p.46-59.

Gouws JF, Majozi T. 2007. Towards an effective scheduling technique for zero effluent multipurpose batch plants. *17th European Symposium on Computer Aided Process Engineering (ESCAPE), Bucharest, Romania, 27-30 May 2007.*

Gouws JF, Majozi T. 2007. Towards the design of a zero effluent facility in the pharmaceutical industry. *10th Conference on Process Integration, Modelling and Optimisation for Energy Saving and Pollution Reduction, Ischia Island, Gulf of Naples, 24-27 June 2007.*

Govender G, Ivanchev LH, Hope D, Burger HP, Kunene G. 2007. A comparative study on laser welding and TIG welding of semi-solid high pressure die cast A356 aluminium alloy. *5th Decennial International Conference on Solidification Processing, University of Sheffield, England, 23-25 July 2007.*

Govender K, Audouin M. 2007. Introduction to SEA. In: Govender K, Adouin M (eds.). *Enhancing the effectiveness of SEA in South Africa*, p.1-20.

Govender K, Audouin M. 2007. Strategic environmental assessment: the chameleon that changes colour. In: Govender K, Adouin M (eds.). *Enhancing the effectiveness of SEA in South Africa*, p.21-27.

Govender K, Audouin M. 2007. Stakeholder engagement: playing a fair game. In: Govender K, Adouin M (eds.). *Enhancing the effectiveness of SEA in South Africa*, p.39-45.

Govender K, Brownlie, Audouin MA. 2007. *Strategic Environmental Assessment Guideline. Integrated Environmental Guideline Series 4*, 80pp.

Govender M, Chetty K, Bulcock H. 2007. A review of hyperspectral remote sensing and its application in vegetation and water resource studies. *Water SA*, 33(2), p.145-151.

Govender N, Barnard E, Davel MH. 2007. Pitch modelling for the Nguni languages. *South African Computer Journal*, 38, p.28-39.

Greben HA, Joubert L-M, Tjatji MP, Whites HE, Botha A. 2007. Biological nitrate removal from synthetic wastewater using a fungal consortium in one stage bioreactors. *Water SA,* 33(2), p.1-6.

Greben HA, Baloyi LJ, Venter SN. 2007. Grass cellulose as cost-effective energy source for biological sulphate removal. *Water SA*, 33(5), p.731-736.

Greben JM. 2007. A theory of quantitative trend analysis and its application to South African general elections. *South African Journal of Science*, 103, p.232-238.

Greeff M, Kotze P. 2007. Individual difficulties faced by persons with mobility impairments. *IADIS Multi Conference on Computer Science and Information Systems (MCCSIS 2007): IADIS International Conference on Interfaces and Human Computer Interaction (IHCI), Lisbon, Portugal, 3-8 July 2007.*

Grundlingh ML, Von St Ange U, Bolton JJ, Bursey M, Compagno L, Cooper R, Drapeau L, Griffiths CL, Bel Hassen M, Herbert DG, Kirkman S, Ohland D, Robertson HG, Trinder-Smith T, Van der Westhuysen J, Verheye HM, Coetzer W, Wilke C. 2007. AfrOBIS: marine biogeographic information system for Sub-Saharan Africa. *South African Journal of Science*, 103(3-4), p.91-93.

Guduri BBR, Rajulu AV, Luyt AS. 2007. Chemical resistance, void contents, and morphological properties of Hildegardia fabric/polycarbonate-toughened epoxy composites. *Journal of Applied Polymer Science*, 106, p.3945-3951.

Guduri BR, Luyt AS. 2007. Comparison of the influence of different compatibilizers on the structure and properties of ethylene vinyl acetate copolymer/modified clay nanocomposites. *Journal of Applied Polymer Science*, 105, p.3612-3617.

Guduri BR, Luyt AS. 2007. Effect of ethylene clycidyl methacrylate compatibilizer on the structure and mechanical properties of clay nano composites modified with ethylene vinyl acetate copolymer. *Journal of Applied Polymer Science*, 103(6), p.4095-4101.

Guduri BR, Khoathane C, Anandjiwala RD, De Veries A, Sadiku ER, Van Wyk L. 2007. Effect of water absorption on mechanical properties of flax fibre reinforced composites. *6th International Conference on Composite Science and Technology, Durban, South Africa, 22-24 January 2007.*

Guduri BR, George S, Lawrence CC, Anandjiwala RD. 2007. The effect of water absorption on mechanical properties of hemp fibre/polyolefin's composites. *Fibre Re-inforced Composites Conference, Port Elizabeth, South Africa, 9-12 December 2007.*

Gueli RJ. 2007. Construction for development (but also for security?). *CIB World Building Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007.*

Gueli RJ, Liebenberg FS. 2007. Developmental peace missions: synergising peacekeeping and peacebuilding in transition periods. In: Aboagye FB (ed.). *Complex Emergencies in the 21st Century: Challenges of New Africa's Strategic Peace and Security Policy Issues. ISS Monograph Series No. 134*, p.73-91.

Gueli RJ, Liebenberg S, Van Huyssteen E. 2007. Integrated development planning in South Africa: lessons for international peace building? *African Journal on Conflict Resolution*, 7(1), p.89-112.

Gueli RJ, Liebenberg S. 2007. Strategies for rebuilding Africa's broken states. In: Southall R (ed.). *Conflict and Governance in South Africa: Moving Towards a More Just and Peaceful Society*, p.300-311.

H

Hacking T, Ramasar V, Patrick MJ, Binedell ML, Muller E, Wright A, Burns MER. 2007. In: Govender K, Adouin M (eds.). *Enhancing the Effectiveness of SEA in South Africa*, p.140.

Halindintwali S, Knoesen D, Swanepoel R, Julies BA, Arendse C, Muller T, Theron CC, Gordijn A, Bronsveld PCP, Rath JK, Schropp REI. 2007. Improved stability of intrinsic nanocrystalline Si thin films deposited by hot wire chemical vapour deposition technique. *Thin Solid Films*, 515(20-21), p.8040-8044.

Hargitai H, Rácz I, Anandjiwala RD. 2007. Development of hemp fiber reinforced polypropylene composites. In: Anandjiwala RD, Hunter L, Kozlowski R, Zaikov G (eds.). *Textiles for Sustainable Development*, p.200-220

Hattingh J, Maree GA, Ashton PJ, Leaner JJ, Rascher J, Turton AR. 2007. Introduction to ecosystem governance: focusing on Africa. *Water Policy Supplement*, 9(S2), p.5-10.

Hattingh J, Maree GA, Ashton PJ, Leaner JJ, Turton AR. 2007. A trialogue model for ecosystem governance. *Water Policy Supplement*, 9(S2), p.11-18.

Hauptfleisch D, Lazarus S, Knoetze TP, Liebenberg S. 2007. An integrated emerging contractor development model for the construction industry: practical implementation and statistical quantification. *CIB World Building Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007.*

Henry G. 2007. Uranium exploration by Esso in the Sutherland area, Northern Cape, during the boom in the late 1970s. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Herselman M. 2007. Business information management system for sustainable health information retrieval in rural communities. *19th International Conference on Systems Research, Informatics and Cybernetics, Baden-Baden, Germany, 31 July-4 August 2007.*

Herselman PLR, Baker CJ. 2007. Analysis of calibrated sea clutter and boat reflectivity data at C- and X-band in South African coastal waters. *RADAR 2007: IET International Conference on Radar Systems, Edinburgh, United Kingdom, 15-18 October 2007.*

Hettasch MH, Verryn SD, Roux CZ. 2007. Investigation of the efficiency of selection indices in non-hardy Weinberg Eucalypt hybrid populations. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Holtmann B, Jansen Van Vuuren C. 2007. Safe society safe mobility. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition, Pretoria, South Africa, 9-12 July 2007.*

Hunter L. 2007. Cotton fibre chemistry and technology. In: Menachem L (ed.). *Handbook of Fiber Chemistry*, p.521-666.

Hunter L. 2007. Cotton's role in sustainable textiles. In: Anandjiwala RD, Hunter L, Kozlowski R, Zaikov G (eds.). *Textiles for Sustainable Development*, p.387-395.

Hunter L. 2007. Cotton spinning technology. In: Gordon S, Hsieh Y-L (eds.). *Cotton: Science and Technology*, p.240-274.

Hunter L. 2007. Testing cotton yarns and fabrics. In: Gordon S, Hsieh Y-L (eds.). *Cotton: Science and technology*, p.381-424.

Hussain I, Gichuki F, Louw MA, Andah W, Moustafa M. 2007. Agricultural water management pathways to breaking the poverty trap: case studies of the Limpopo, Nile and Volta river basins. *Irrigation and Drainage*, 56(2), p.277-288.

I

Ittmann HW, Van Dyk FE, Meyer IA, Janse Van Rensburg SJ. 2007. Operations research at CSIR: a brief history in cases. *ORiON: Journal of the Operational Research Society of South Africa*, 23(1), p.73-88.

Ive O, Wall K, Bhagwan J. 2007. Franchising partnerships to improve municipal water services operation. *71st Institute of Municipal Engineering of Southern Africa (IMESA) Conference: Sustainable Municipal Engineering 2010 and Beyond, Durban, South Africa, 23-26 October 2007.*

J

Jacob GE, Zeevaart JG, Parkinson CJ, De Koning CB. 2007. Copper(I) iodide-catalysed arylation of acetoacetate to yield 2-arylacetic acid esters. *Tetrahedron Letters*, 48(18), p.3289-3293.

James I, Hoffman T, Munro A, O'Farrell PJ, Smart R. 2007. The economic value of flower tourism at the Namaqua National Park, South Africa. *South African Journal of Economic and Management Sciences*, 10(4), p.444-458.

Janse Van Rensburg SJ, Harmse M. 2007. Capacity modelling of the coal value chain at Sasol Coal Supply. *18th International Association of Science and Technology for Development (IASTED) Conference: Modelling and Simulation, Quebec, Montreal, Canada, 30 May-1 June 2007.*

John MJ, Anandjiwala RD, Pothan LA, Thomas S. 2007. Cellulosic fibre-reinforced green composites. *Composite Interfaces*, 14(7), p.733-751.

John MJ, Indira KN, Geethamma VG, Shaji J, Thomas S. 2007. Coir and hemp fiber-reinforced polymer composites. In: Fakirov S, Bhattacharyya D (eds.). *Handbook of Engineering Biopolymers: Homopolymers, Blends and Composites*, p 285-309.

Johnson DL, Lysko A. 2007. Overview of the Meraka wireless grid test bed for evaluation of ad-hoc routing protocols. *Southern African Telecommunication Networks and Applications Conference (SATNAC 2007), Mauritius, 9-13 September 2007.*

Johnson FX, Woods J, Rosillo-Calle F, Brown G, Seebaluck V, Watson H, Yamba F, Mapako M, Jolly L, Farioli F, Leal MRLV, Sobhanbabu PRK. 2007. Cane energy for sustainable development and economic competitiveness in Southern Africa. *The XXVI Congress of the International Society of Sugarcane Technologists, Durban, South Africa, 29 July-2 August 2007.*

Jones DJ. 2007. Development of performance based tests for nontraditional road additives. In: Transportation Research Board United States of America. In: *Low-Volume Roads 2007*, vol 2, p.142-153.

Juuti PS, Maki HRJ, Wall K. 2007. Water supply in the Cape settlement from the mid-17th to the mid-19th centuries. In: Juuti PS, Katko TS, Vuorinen HS (eds.). *Environmental History of Water: Global Views on Community Water Supply and Sanitation*, p.165-173.

K

Kalapureddy MCR, Kumar KK, Sivakumar V, Ghosh AK, Jain AR, Reddy KK. 2007. Diurnal and seasonal variability of TKE dissipation rate in the ABL over a tropical station using UHF wind profiler. *Journal of Atmospheric and Solar-Terrestrial Physics*, 69(4-5), p.419-430.

Kalua F, Mumba LE, Maharaj V. 2007. Scientific validation of traditional medicines for affordable treatments for HIV and HIV opportunistic infections. *1st NEPAD/SANBio Workshop on Scientific Validation of Traditional Medicine for Affordable Treatments of HIV/AIDS and Opportunistic Infections, Lusaka, Zambia, 15-16 March 2007.*

Kannemeyer L, Perrie B, Strauss P, Du Plessis L. 2007. Ultra thin continuously reinforced concrete pavement research in South Africa. *International Conference on Concrete Roads (ICCR), Johannesburg, Midrand, South Africa, 16-17 August 2007.*

Kareem TR, Chan HA. 2007. A low-cost design of next generation SONET/SDH networks with multiple constraints. *IEEE Africon 2007, Windhoek, Namibia, 26-28 September 2007.*

Kato RSM, Barnard E. 2007. Statistical translation with scarce resources: a South African case study. *SAIEE Africa Research Journal*, 98(4), p.136-140.

Katumba G, Mwakikunga B, Lu J, Forbes A, Wäckelgård E, Makiwa LOG. 2007. The investigation of carbon nanoparticles embedded in ZnO and NiO as selective solar absorber surfaces. *ISES Solar World Congress 2007: Solar Energy and Human Settlement, Beijing, China, 18-21 September 2007.*

Keith M, Chimimba CT, Reyers B, Van Jaarsveld AS. 2007. A comparative analysis of components incorporated in conservation priority assessments: a case study based on South African species of terrestrial mammals. *African Zoology*, 42(1), p.97-111.

Kgarume T, Spottiswoode SM. 2007. Analysis of aftershock decay rates of mine seismic events. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Kimmie Z, Delany A, Khumalo B. 2007. Community surveys. In: Joubert G, Ehrlich R (eds.). *Epidemiology: a Research Manual for South Africa*, p.188-200.

Kirchmann S, Van Zyl PJ, Brady D, Abrahams N, Rech S, Dorrington R, Burton S. 2007. A dual phase fermentation protocol for the production of hydantoinase and carbamoylase by the wild type of *Pseudomonas putida* RU-KM3S. *Enzyme and Microbial Technology*, 41(4), p.539-545.

Knight AT, Smith RS, Cowling RM, Desmet PG, Faith DP, Ferrier S, Gelderblom CM, Grantham H, Lombard AT, Maze K, Nel JL, Parrish JD, Pence GQK, Possingham HP, Reyers B, Rouget M, Roux D, Wilson KA. 2007. Improving the key biodiversity areas approach for effective conservation planning. *Bioscience*, *57*(3), p.256-261.

Kostinek M, Specht I, Edward VA, Pinto C, Egounlety M, Sossa C, Mbugua S, Dortu C, Thonart P, Taljaard L, Mengu M, Franz CMAP, Holzapfel WH. 2007. Characterisation and biochemical properties of predominant lactic acid bacteria from fermenting cassava for selection as starter cultures. *International Journal of Food Microbiology*, 114(3), p.342-351.

Krug T, Botha L, Shamba P, Baisitse TR, Venter A, Engelbrecht JAA, Botha JR. 2007. Electrical properties of undoped and doped MOVPE-grown InAsSb. *Journal of Crystal Growth*, 298, p.163-167.

Kruger T, Landman K. 2007. Crime and public transport: designing a safer journey. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Krygsman SC, de Jong T, Schmitz PMU. 2007. Capturing daily urban rhythms: the use of location aware technologies. *10th International Computers in Urban Planning and Urban Management Conference, Iguassu Falls, Brazil, 11-13 July 2007.*

Kumile CM, Tlale NS, Bright G. 2007. Automated Visual Inspection System (AVIS) for computer integrated manufacturing. *23rd ISPE International Conference on CAD/CAM Robotics and Factories of the Future, Bogota, Colombia, 16-18 August 2007.*

Kumile CM, Tlale NS, Bright G. 2007. Mechatronic sensory system for computer integrated manufacturing. *International Conference on Manufacturing Automation (ICMA 2007), National University of Singapore, Singapore, 28-30 May 2007.*

Kumile CM, Tlale NS. 2007. Perspectives of modular mechatronics in product design and development. *10th Botswana Institute of Engineers Biennial Conference, Gaborone, Botswana, 17-19 October 2007.*

Kumile CM, Tlale NS, Bright G. 2007. A review of modular mechatronics. *23rd ISPE International Conference on CAD/CAM Robotics and Factories of the Future, Bogota, Colombia, 16-18 August 2007.*

Kumile CM, Tlale NS, Bright G. 2007. Sensor fusion control system for computer integrated manufacturing. *23rd ISPE International Conference on CAD/CAM Robotics and Factories of the Future, Bogota, Colombia, 16-18 August 2007.*

Kunene N, Nesamvuni EA, Fossey A. 2007. Characterisation of Zulu (Nguni) sheep using linear body measurements and some environmental factors affecting these measurements. *South African Journal of Animal Science*, 37(1), p.11-20.

L

Labuschagne M, Albertyn J. 2007. Cloning of an epoxide hydrolase encoding gene from Rhodotorula mucilaginosa and functional expression in *Yarrowia lipolytica*. *Yeast*, 24(2), p.69-78.

Lakay FM. 2007. Comparative analysis of environmental DNA extraction and purification methods from different humic acid rich soils. *Journal of Applied Microbiology*, 102(1), p.265-273.

Lalloo R, Ramchuran SO, Ramduth DM, Gorgens J, Gardiner NS. 2007. Isolation and selection of *Bacillus* spp as potential biological agents for enhancement of water quality in culture of ornamental fish. *Journal of Applied Microbiology*, 103(5), p.1471-479.

Lamprecht GH, Human HGC, Snyman LW. 2007. Detection of diamond in ore using pulsed laser Raman spectroscopy. *International Journal of Mineral Processing*, 84(1-4), p.262-273.

Landman K. 2007. Defensive architecture in South Africa: the story behind the walls and gates. *Architecture SA*, May 2007.

Landman K. 2007. Exploring the impact of gated communities on social and spatial justice and its relation to restorative justice and peace-building in South Africa. *Acta Juridica*, p.134-155.

Landman K, Du Plessis C. 2007. The impact of gated communities on urban sustainability: a difference of opinion or a matter for concern? *Town and Regional Planning*, 51, p.16-25.

Landman K. 2007. The storm that rocks the boat: the systemic impact of gated communities on urban sustainability. *Cybergeo*, 399, p1-17.

Le Maitre DC, O'Farrell PJ, Reyers B. 2007. Ecosystems services in South Africa: a research theme that can engage environmental, economic and social scientists in the development of sustainability science? *South African Journal of Science*, 103(9-10), p.367-376.

Le Maitre DC, Milton SJ, Jarmain C, Colvin CA, Saayman IC, Vlok JHJ. 2007. Linking ecosystem services and water resources: landscape-scale hydrology of the Little Karoo. *Frontiers in Ecology and the Environment*, 5(5), p.261-270.

Le Roux WH, Nel JJ, Steinberg AN. 2007. Using a data fusion-based activity recognition framework to determine surveillance system requirements. *10th Conference of the International Society of Information Fusion (Fusion 2007), Quebec, Canada, 9-12 July 2007.*

Leaner JJ, Dabrowski JM, Murray K, Ashton PJ, Mason RP, Zunckel M, Oosthuizen R. 2007. Mercury research for policy development in South Africa. In: Zhu Y, Lepp N, Naidu R (eds.). *Biogeochemistry of trace elements: Environmental Protection, Remediation and Human Health*, p.478-479.

Leary N, Adejuwon J, Bailey V, Barros V, Batima P, Caffera M, Chinvanno S, Conde C, DeComarmond A, De Sherbinin A, Downing T, Eakin H, Nyong A, Opondo M, Osman B, Payet R, Puhlin F, Puhlin J, Sanjak E, Ratnisiri J, Von Maltitz GP, Wehbe M, Yin Y, Ziervogel G. 2007. For whom the bell tolls: vulnerabilities in a changing climate. In: Leary N, Conde C, Kulkarni J, Nyong A, Pulhin J (eds.). *Climate Change and Vulnerability*, p.33-48.

Leenen L, Anbulagan, Meyer T, Ghose A. 2007. Modelling and solving semiring constraint satisfaction problems by transformation to weighted semiring Max-SAT. *20th Australian Joint Conference on Artificial Intelligence: Advances in Artificial Intelligence, Gold Coast, Australia, 2-6 December 2007.*

Leenen L, Meyer T, Ghose A. 2007. Relaxations of semiring constraint satisfaction problems. *Information Processing Letters*, 103(5), p.177-182.

Levecque P, Gammon D, Kinfe HH, Jacobs P, De Vos D, Sels B. 2007. Epoxidation-alcoholysis of cyclic enol ethers catalyzed by Ti(O(i)Pr)4 or Venturello's peroxophosphotungstate complex. *Organic & Biomolecular Chemistry*, 5(11), p.1800-1806.

Linde LP, Vlok JD. 2007. A multi-dimensional super-orthogonal modulation alternative to M-QAM WCDMA for next generation wireless applications. *IEEE Africon 2007, Windhoek, Namibia, 26-28 September 2007.*

Linzer LM, Bejaichund M, Cichowicz A, Durrheim RJ, Goldbach OD, Kataka MO, Kijko A, Milev AM, Saunders I, Spottiswoode SM, Webb SJ. 2007. Recent research in seismology in South Africa. *South African Journal of Science*, 103, p.419-426.

Litvin IA, Burger L, Forbes A. 2007. Analysis of transverse field distributions in porroprism resonators. *XVI International Symposium on Gas Flow, Chemical Lasers, and High-Power Lasers, Austria, 4-8 August 2006.*

Litvin IA, Forbes A. 2007. Impact of phase errors at the conjugate step on the propagation of intensity and phase shaped laser beams. *Laser Beam Shaping VIII, San Diego, California, U.S.A., 28-29 August 2007.*

Litvin IA, Burger L, De Gama MP, Mathye A, Forbes A. 2007. Laser beam shaping limitations for laboratory simulation of turbulence using a phase-only spatial light modulator. *Laser Beam Shaping VIII, San Diego, California, U.S.A., 28-29 August 2007.*

Litvin IA, Burger L, Forbes A. 2007. Petal-like modes in Porro prism resonators. *Optics Express*, 15(21), p.14065-14077.

Liu I-S, Takawira F, Xu HJ. 2007. Optimization of hybrid token-CDMA MAC system using cross-layer information. *Southern African Telecommunications, Networks and Applications Conference (SATNAC), Mauritius, 9-12 September 2007.*

Liu I-S, Takawira F, Xu HJ. 2007. Performance analysis for a QoS-aware hybrid token-CDMA MAC protocol. *18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'07), Athens, Greece, 3-7 September 2007.*

Liu YS, Takawira F, Xu HJ. 2007. Approximate discrete time analysis of the hybrid Token-CDMA MAC system. *IEEE Africon 2007, Windhoek, Namibia, 26-28 September 2007.*

Lombard AT, Reyers B, Schonegevel LY, Coopers J, Smith-Adao LB, Nel DC, Froneman PW, Ansorge IJ, Bester MN, Tosh CA, Strauss T, Akkers T, Gon O, Leslie RW, Chown SL. 2007. Conserving pattern and process in the southern ocean: designing a marine protected area for the Prince Edward Islands. *Antarctic Science*, 19(1), p.39-54.

Lombard M, Cameron B, Mokonyama M, Shaw A. 2007. *Report on Trends in Passenger Transport in South Africa*, 121pp.

Long CS, Loveday PW. 2007. A thermo-hydraulic wax actuation system for high force and large displacement applications. *Industrial and Commercial Applications of Smart Structures Technologies 2007, San Diego, California, U.S.A., 19-20 March 2007.*

Loveday PW. 2007. Analysis of piezoelectric ultrasonic transducers attached to waveguides using waveguide finite elements. *IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control*, 54(10), p.2045-2051.

Loveday PW, Long CS. 2007. Time domain simulation of piezoelectric excitation of guided waves in rails using waveguide finite elements. *Sensors and Smart Structures Technologies for Civil, Mechanical and Aerospace Systems 2007, San Diego, California, U.S.A., 19-22 March 2007.*

M

Mabuza LOK, Brent AC, Mapako M. 2007. The transfer of energy technologies in a developing country context: towards improved practice from past successes and failures. *World Academy of Science, Engineering and Technology International Conference, Prague, Czech Republic, 27-29 July 2007.*

Mafusire C, Forbes A, Snedden GC, Michaelis MM. 2007. Characterisation of a spinning pipe gas lens using a Shack-Hartmann wavefront sensor. *Laser Beam Shaping VIII, San Diego, California, U.S.A., 28-29 August 2007.*

Mahachi J, Khanye L, Goliger AM. 2007. Calibration of brick masonry partial safety factors for the South African code. *SEMC 2007: 3rd International Conference on Structural Engineering, Mechanics and Computation, Cape Town, South Africa, 10-12 September 2007.*

Maina JW, De Beer M, Matsui K. 2007. Effects of layer interface slip on the response and performance of elastic multi-layered flexible airport pavement systems. *5th International Conference on Maintenance and Rehabilitation of Pavements and Technological Control (MAIREPAV5), Park City, Utah, U.S.A., 8-10 August 2007.*

Maity A, Ray SS, Pillai SK. 2007. Morphology and electrical conductivity of poly(N-vinylcarbazole)/carbon nanotubes nanocomposite synthesized by solid state polymerization. *Macromolecular Rapid Communications*, 28(23), p.2224-2229.

Malzbender D, Goldin J, Turton A, Earle A. 2007. Traditional water governance and South Africa's "National Water Act": tension or cooperation? In: Ramani W (ed.). *Good Governance: Perspectives and Experiences*, p.136-160.

Manus A, Wall K, Ottermann A. 2007. From fact-finding to priority actions: the national water services IAM strategy study. *71st Institute of Municipal Engineering of Southern Africa (IMESA) Conference: Sustainable Municipal Engineering 2010 and Beyond, Durban, South Africa, 23-26 October 2007.*

Mapako M, Prasad G. 2007. Rural electrification in Zimbabwe reduces poverty by targeting income-generating activities. *15th Conference on Domestic Use of Energy, Cape Town, South Africa, 11-12 April 2007.*

Mapako M, Mosomane L, Mukwevho L. 2007. Small enterprises and their energy use in the Umkhanyakude district, Kwazulu Natal, South Africa. *5th Conference on Domestic Use of Energy, Cape Town, South Africa, 11-12 April 2007.*

Martirosian OM, Davel MH. 2007. Error analysis of a public domain pronunciation dictionary. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Martirosian OM, Barnard E. 2007. Speech-based emotion detection in a resource-scarce environment. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Masekamela I, Tlale NS, Kumile CM. 2007. Design of a real-time open architecture control system for reconfigurable manufacturing system. *10th Botswana Institute of Engineers Biennial Conference, Gaborone, Botswana, 17-19 October 2007.*

Mashiri MAM, Dube S, Buiten D. 2007. Fostering child-centred approaches to transport research, planning and policy development: a pilot methodology. *Commonwealth Youth and Development*, 5(2), p.15.

Mashiri MAM, Kistan KF, Marrian B, Elrahman OA. 2007. Uplifting developing communities through sustained technology transfer. *3rd Africa Technology Transfer Conference: Technology Transfer for Africa's Sustainable Transportation System, Mangochi, Malawi, 22-25 May 2007.*

Matsebe O, Kumile CM, Tlale NS. 2007. Design of a multi-sensor environment recognition and control system for an autonomous underwater vehicle (AUV). *10th Botswana Institute of Engineers Biennial Conference, Gaborone, Botswana, 17-19 October 2007.*
Mc Dougall I. 2007. Finite element modelling of electric currents in AC submerged arc furnaces. *INFACON XI, New Delhi, India, 8-21 February 2007.*

McFerren GA, Roos S, Terhorst AL. 2007. Fire alerts for the geospatial web. In: Scharl A, Tochtermann, K (eds.). *The Geospatial Web: How Geo-Browsers, Social Software and the Web 2.0 are shaping the Network Society*, p.20-34.

Meyer R, Van Schoor AM, Greben JM. 2007. Development of and tests with the NMR technique to detect water bearing fractures. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Mgidi TN, Le Maitre DC, Schonegevel LY, Nel JL, Rouget M, Richardson DM. 2007. Alien plant invasions: incorporating emerging invaders in regional prioritization: a pragmatic approach for Southern Africa. *Journal of Environmental Management*, 84(2), p.173-187.

Michira I, Akinyeye R, Somerset VS, Klink M, Sekota M, Al-Ahmed A, Baker P, Iwuoha E. 2007. Synthesis, characterisation of novel polyaniline nanomaterials and application in amperometric biosensors. *Macromolecular Symposia*, 255(1), p.57-69.

Mkwelo SG, Nicolls F, De Jager G. 2007. Range and intensity vision for rock-scene segmentation. *Iberoamerican Congress on Pattern Recognition (CIARP) 2007, Valparaiso, Chile, 13-16 November 2007.*

Mkwelo SG, De Jager G, Nicolls F. 2007. Range sections as rock models for intensity rock scene segmentation. *18th Annual Symposium of the Pattern Recognition Association of South Africa (PRASA 2007), Pietermaritzburg, South Africa, 28-30 November 2007.*

Mng'omba SA, Du Toit ES, Akinnifesi FK, Venter HM. 2007. Repeated exposure of jacket plum (*Pappea capensis*) micro-cuttings to indole-3-butyric acid (IBA) improved in vitro rooting capacity. *South African Journal of Botany*, 73, p.230-235.

Mokonyama MT, Venter C. 2007. Forecasting household car ownership in South Africa: alternative models and future trends. *Journal of the SA Institution of Civil Engineering*, 49(3), p.2-10.

Morris CF. 2007. First mile, first inch. *IST-Africa Conference, Maputo, Mozambique, 9-11 May 2007.*

Mostert ME, Botha BM, Du Plessis LM, Duodu KG. 2007. Effect of fruit ripeness and method of fruit drying on the extractability of avocado oil with hexane and supercritical carbon dioxide. *Journal of the Science of Food and Agriculture*, 87(15), p.2880-2885.

Motaung SR, Mangena SJ, De Korte GJ, McCrindle RI, Van Heerden JHP. 2007. Effects of coal composition and flotation reagents on the water resistance of binderless briquettes. *Coal Preparation*, 27(4), p.230-248.

Mpofu K, Bolele K, Kumile CM, Tlale NS. 2007. Development of a knowledge based reconfigurable manufacturing system. *10th Botswana Institute of Engineers Biennial Conference, Gaborone, Botswana, 17-19 October 2007.*

Mtwisha L, Farrant JM, Brandt W, Hlongwane C, Lindsey GG. 2007. ASP53, a thermostable protein from *Acacia erioloba* seeds that protects target proteins against thermal denaturation. *Functional Plant Biology*, 34(2), p.139-149.

Muller EA, Burns M. 2007. Indicators: Are we on the right track? In: Govender K, Adouin M (eds.). *Enhancing the Effectiveness of SEA South Africa*, p.75-83.

Mulugeta G, Ayonghe S, Daby D, Dube P, Gudyanga F, Lucio F, Durrheim RJ. 2007. *Natural and Human-Induced Hazards and Disasters in Sub-Saharan Africa*, 30pp.

Musango JK, Peter C. 2007. A Bayesian approach towards facilitating climate change adaptation research on the South African agricultural sector. *Agrekon*, 46(2), p.245-259.

Musee N, Lorenzen L. 2007. Assessing sustainability of gold mining operations using fuzzy logic methodology. *Australasian Institute of Mining and Metallurgy (AusIMM) World Gold Conference 2007: By- and Co-Products and the Environment, Cairns, Australia, 22-24 October 2007.*

Musee N, Lorenzen L, Aldrich C. 2007. Modelling undissolved gold losses in an industrial plant with Neurofuzzy methods. *Australasian Institute of Mining and Metallurgy (AusIMM) World Gold Conference 2007: By- and Co-Products and the Environment, Cairns, Australia, 22-24 October 2007.*

Musee N, Lorenzen L. 2007. A tutorial on international trends of effluent management in gold mining plants. *Gold Processing Workshop 2007: International Symposium on Current and Emerging Technologies and Their Practical Applications in Gold Processing, Cairns, Australia, 20-21 October 2007.*

Musvoto C, Mapaure I, Gondo T, Ndeinoma A, Mujawo T. 2007. Reality and preferences in community mopane (*Colophospermum mopane*) woodland management in Zimbabwe and Namibia. *Proceedings of the World Academy of Science, Engineering and Technology (WASET), Prague, Czech Republic, 27-29 July 2007.*

N

Naicker D, Marais GJ, Van den Berg H, Masango MG. 2007. Some fungi, zearalenone and other mycotoxins in chicken rations, stock feedstuffs, lucerne and pasture grasses in the communal farming area of Rhenosterkop in South Africa. *Journal of the South African Veterinary Association*, 78(2), p.69-74.

Naidoo S, Zbonak A, Pammenter NW, Ahmed F. 2007. Assessing the effects of water availability and soil characteristics on selected wood properties of *E. grandis* in South Africa. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Namoshe M, Kumile CM, Tlale NS. 2007. Development and implementation of algorithms in a population of cooperative autonomous mobile robots. *10th Botswana Institute of Engineers Biennial Conference, Gaborone, Botswana, 17-19 October 2007.*

Naude AH, Maritz J. 2007. The emerging potential for radical e-enabled improvements in rural collaboration and accessibility. *IST-Africa 2007 Conference and Exhibition, Maputo, Mozambique, 9-11 May 2007.*

Ndlovu ZTL, Zbonak A, Swain T-L, Fossey A. 2007. Development of a non-destructive near-infrared sampling technique to determine screened pulp yield of *Eucalyptus macarthurii*. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Nel JJ, Roodt JH, Oosthuizen R. 2007. The design of the M&S acquisition support effort of the SANDF GBADS acquisition programme. *Simulation Conference (SimTecT 2007): Simulation: Improving Capability and Competitiveness, Brisbane, Queensland, Australia, 4-7 June 2007.*

Nel JJ, Baird HJ. 2007. Modelling and simulation in support of the SANDF GBADS acquisition programme: an update. *South African Joint Air Defence Symposium, Pretoria, South Africa, 30-31 May 2007.*

Nel JL, Roux DJ, Maree GA, Kleynhans CJ, Moolman J, Reyers B, Rouget M, Cowling RM. 2007. Rivers in peril inside and outside protected areas: a systematic approach to conservation assessment of river ecosystems. *Diversity & Distributions*, 13(3), p.341-352.

Newman BK, Wooldridge TH, Cockcroft AC. 2007. Aspects of the biology and ecology of the estuarine cirolanid isopod, *Cirolana fluviatilis*. *African Zoology*, 42(1), p.12-22.

Newman BK, Watling RJ. 2007. Definition of baseline metal concentrations for assessing metal enrichment of sediment from the south-eastern Cape coastline of South Africa. *Water SA*, 33(5), p.675-691.

Ngcobo P, Herselman ME. 2007. Evaluating ICT provision in selected communities in South Africa. *InSite Conference, Ljubljana, Slovenia, 22-25 June 2007.*

Nocanda X, Larsson PT, Spark A, Bush TLD, Olsson A, Madikane M, Bissessur A, Iversen T. 2007. Cross polarisation/magic angle spinning 13C-NMR spectroscopic studies of cellulose structural changes in hardwood dissolving pulp process. *Holzforschung*, 61(6), p.675-679.

Nordengen PA. 2007. The Road Transport Management System (RTMS): a self regulation initiative in heavy vehicle transport in South Africa. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Nyareli TN, Vogt DR. 2007. Small directional borehole radar antennas: numerical modelling method. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Nyirenda CN, Dawoud DS. 2007. Fuzzy logic congestion control in IEEE 802.11 wireless local area networks: a performance evaluation. *IEEE Africon Conference 2007, Windhoek, Namibia. 26-28 September 2007.*

Nyoka M, Brent AC. 2007. Application of an environmental valuation approach that incorporates externality costs in sustainability decision-making of the metallurgical sector. *Journal of the South African Institute of Mining and Metallurgy*, 107(10), p.663-669.

O

O'Farrell PJ, Donaldson JS, Hoffman MT. 2007. The influence of ecosystem goods and services on livestock management practices on the Bokkeveld plateau, South Africa. *Agriculture, Ecosystems and Environment*, 122(3), p.312-324.

O'Kennedy MM, Girgi M. 2007. Pearl millet. In: Pua EC, Davey MR (eds.). *Transgenic Crops IV. Biotechnology in Agriculture and Forestry*, 59, p.119-127.

Oberholster PJ, Botha A-M, Cloete TE. 2007. Ecological implications of artificial mixing and bottom-sediment removal for a shallow urban lake, Lake Sheldon, Colorado. *Lakes & Reservoirs: Research and Management*, 12(2), p.73-86.

Oberholster PJ, Botha A-M. 2007. Use of PCR based technologies for risk assessment of a winter cyanobacterial bloom in Lake Midmar, South Africa. *African Journal of Biotechnology*, 6(15), p.1794-1805.

Odendaal JW, Botha L, Joubert J. 2007. A full-scale static radar cross-section (RCS) measurement facility. *South African Journal of Science*, 103(5-6), p.196-198.

Odhiambo JO. 2007. Agrément South Africa certification as assistance to the roads engineer. *3rd Africa Technology Transfer Conference: Technology Transfer for Africa's Sustainable Transportation System, Mangochi, Malawi, 22-25 May 2007.*

Oelofse SHH, Adlem CJL, Hattingh J. 2007. Overcoming bureaucratic obstacles to the re-use of metallurgical slag: a South African case study. *10th International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production (SWEMP 2007), Bangkok, Thailand, 11-13 December 2007.*

Oelofse SHH, Hobbs PJ, Rascher J, Cobbing JE. 2007. The pollution and destruction threat of gold mining waste on the Witwatersrand: a West Rand case study. *10th International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production (SWEMP 2007), Bangkok, Thailand, 11-13 December 2007.*

Olivier JC, Araya ST, Wessels KJ. 2007. Detection of land cover change using an artificial neural network on a time-series of MODIS satellite data. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Olivrin GJ. 2007. Gesture modelling for linguistic purposes. *GW2007: The 7th International Workshop on Gesture in Human-Computer Interaction and Simulation, Lisbon, Portugal, 23-25 May 2007.*

Olson GM, David PA, Eksteen JJ, Sonnenwald DH, Uhlir PF, Tseng S, Huang H. 2007. International collaborations through the Internet. In: Shrum W, Benson KR, Bijker WE, Brunnstein K (eds.). *Past, Present and Future of Research in the Information Society*, p.97-113.

Oranje M, Van Huyssteen E. 2007. A brief history of intergovernmental development planning in post-apartheid South Africa. *Town and Regional Planning*, 51, p.1-15.

P

Paige-Green P. 2007. Durability testing of basic crystalline rocks and specification for use as road base aggregate. *Bulletin of Engineering Geology and the Environment*, 66(4), p.431-440.

Paige-Green P. 2007. Improved material specifications for unsealed roads. *Quarterly Journal of Engineering Geology and Hydrogeology*, 40(2), p.175-179.

Patrick MJ, Ellery WN. 2007. Plant community and landscape patterns of a floodplain wetland in Maputaland, northern KwaZulu-Natal, South Africa. *African Journal of Ecology*, 45(2), p.175-183.

Peche M, Davel MH, Barnard E. 2007. Phonotactic spoken language identification with limited training data. *Interspeech 2007, Antwerp, Belgium, 27-31 August 2007.*

Pecku S, Van Der Merwe TL, Rolfes H, Focke WW. 2007. Starch as antiblocking agent in breathable polyurethane membranes. *Journal of Vinyl and Additive Technology*, 13(4), p.215-220.

Pelly SC, Govender S, Fernandes MA, Schmalz GH, De Koning CB. 2007. Stereoselective syntheses of the 2-isopropenyl-2,3-dihydrobenzofuran nucleus: potential chiral building blocks for the syntheses of tremetone, hydroxytremetone and rotenone. *Journal of Organic Chemistry*, 72(8), p.2857-2864.

Perritt SH, Watkeys MK. 2007. The effect of environmental controls on the metal content in ferromanganese crusts and nodules from the Mozambique ridge and in the Mozambique basin, southwestern Indian Ocean. *South African Journal of Geology*, 110(2-3), p.295-310.

Perritt SH, Roberts MKC. 2007. Flexural-slip structures in the Bushveld Complex, South Africa. *Journal of Structural Geology*, 29(9), p.1422-1429.

Peter C, Potgieter A, Monteiro PMS, De Wit MP. 2007. Engineering social-ecological system resilience. *1st International Workshop on Complexity and Organisational Resilience, Pohnpei, Micronesia, 24-25 May 2007.*

Pillai SK, Ray SS, Moodley M. 2007. Purification of single-walled carbon nanotubes. *Journal of Nanoscience and Nanotechnology*, 7(9), p.3011-3047.

Pillay P, Maharaj VJ, Vleggaar R, Smith PJ, Lategan CA, Chouteau F, Chibale K. 2007. Antiplasmodial hirsutinolides from *Vernonia staehelinoides* and their utilization towards a novel simplified pharmacophore. *Phytochemistry*, 68(8), p.1200-1205.

Pillay P, Maharaj VJ. 2007. Isolation and identification of antiplasmodial sesquiterpene lactones from *Oncosiphon piluliferum*. *Journal of Ethnopharmacology*, 112(1), p.71-76.

Pinches SE, Apps PJ. 2007. Production in food of 1,3-pentadiene and styrene by *Trichoderma* species. *International Journal of Food Microbiology*, 116(1), p.182-185.

Polyanin A, Fedotov I, Shatalov M. 2007. Theory of free and forced vibrations of a rigid rod based on the Rayleigh model. *Doklady Physics*, 52(11), p.607-612.

Potgieter PF, Olivier JC. 2007. Inferring radar mode changes from elementary pulse features using Fuzzy ARTMAP classification. *2007 International Conference on Wavelet Analysis and Pattern Recognition, Beijing, China, 2-4 November 2007.*

Prince SD, Wessels KJ, Tucker CJ, Nicholson SE. 2007. Desertification in the Sahel: a reinterpretation of a reinterpretation. *Global Change Biology*, 13(7), p.1308-1313.

Prinsloo FJ, Van Heerden SP, Ronander E, Botha LR. 2007. Efficient TEA CO2 laser based coating removal system. *XVI International Symposium on Gas Flow, Chemical Lasers and High-Power Lasers, Gmunden, Austria, 4-8 August 2006.*

R

Raghunandan A, Mahumane G, Diab R. 2007. Elevated ozone events over Johannesburg based on analysis of tropospheric ozone partial columns. *South African Journal of Science*, 103(3/4), p.248-252.

Rashamuse KJ, Burton SG, Cowan DA. 2007. A novel recombinant ethyl ferulate esterase from *Burkholderia multivorans*. *Journal of Applied Microbiology*, 103(5), p.1610-1620.

Rashamuse KJ, Burton SG, Stanfford WHL, Cowan DA. 2007. Molecular characterization of a novel family VIII esterase from *Burkholderia multivorans* UWC10. *Journal of Molecular Microbiology and Biotechnology*, 13(1-3), p.181-188.

Rawal A, Anandjiwala R. 2007. Comparative study between needlepunched nonwoven geotextile structures made from flax and polyester fibres. *Geotextiles and Geomembranes*, 25(1), p.61-65.

Ray SS, Bandyopadhyay J, Bousmina M. 2007. Effect of organoclay on the morphology and properties of poly(propylene)/poly[(butylene succinate)-co-adipate] blends. *Macromolecular Materials and Engineering*, 292(6), p.729-747.

Ray SS, Bandyopadhyay J, Bousmina M. 2007. Thermal and thermomechanical properties of poly[(butylene succinate)-co-adipate] nanocomposite. *Polymer Degradation and Stability*, 92(5), p.802-812.

Reyers B, McGeoch MA. 2007. A biodiversity monitoring framework for South Africa: progress and directions. *South African Journal of Science*, 103, p.295-300.

Reyers B, Rouget M, Jonas Z, Cowling RM, Driver A, Maze K, Desmet P. 2007. Developing products for conservation decision-making: lessons from a spatial biodiversity assessment for South Africa. *Diversity and Distributions*, 13(5), p.608-619.

Ribbens H. 2007. Limpopo PAVE strategy: a new approach to provincial traffic resource management in South Africa. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Ripamonti J, Richter PW, Nilen RWN, Ramoshebi LN, Renton L, Heliotis M. 2007. Biomimetic smart hydroxyapatite/biphasic tricalcium phosphate biomatrices induce bone formation. *20th International Symposium on Ceramics in Medicine: the Annual Meeting of the International Society for Ceramics in Medicine (ISCM), Nantes, France, 24-26 October 2007.*

Ripamonti U, Richter PW, Thomas ME. 2007. Self-inducing shape memory geometric cues embedded within smart hydroxyapatite-based biomimetic matrices. *Plastic and Reconstructive Surgery*, 120(7), p.1796-1807.

Roberts DE, Du Plessis A, Ombinda-Lemboumba S. 2007. Hard target UV lidar measurements of isoprene mixing ratios and emission rates from eucalyptus trees. *Applied Optics*, 46(25), p.6344-6349.

Roberts DE, Modise TS. 2007. Laser removal of loose uranium compound contamination from metal surfaces. *Applied Surface Science*, 253(12), p.5285-5267.

Roberts JW, Tesfamichael S, Gebreslasie M, Ahmed FB, Van Aardt, JAN. 2007. Forest structural assessment using remote sensing technologies: an overview of the current state of the art. *Southern Hemisphere Forestry Journal*, 69(3), p.183-203.

Robins NS, Chilton PJ, Cobbing JE. 2007. Adapting existing experience with aquifer vulnerability and groundwater protection for Africa. *Journal of African Earth Sciences*, 47(1), p.30-38.

Roodt JHS. 2007. Explorations in complex thinking. In: Richardson KA, Cilliers P (eds.). *Non-Quantitative Modelling as a Framework for the Analysis of Complex Systems*, p.213-222.

Roos TH, Zwane NX, Kruger E, Perumal S, Cathro R. 2007. A 25m^2 target-aligned heliostat with closed-loop control. *ISES Solar World Congress 2007: Solar Energy and Human Settlement, Beijing, China, 18-21 September 2007*.

Roos TH, Kruger E. 2007. Effect of T56 preswirl cooling modelling on disc assembly temperature prediction. *18th ISABE Conference, Beijing, China, 2-7 September 2007*.

Rousseau AL, Matlaba M P, Parkinson CJ. 2007. Multicomponent synthesis of imidazo[1,2-a] pyridines using catalytic zinc chloride. *Tetrahedron Letters*, 48(23), p.4079-4082.

Roux DJ, Murray K, Van Wyk E. 2007. Principles enabling learning environments for good ecosystem governance. In: Turton AR, Hattingh HJ, Maree GA, Roux DJ, Claassen M, Strydom WF (eds.). *Governance as a Trialogue: Government-Society-Science in Transition*, p.253-280.

Roux PJD. 2007. Video-on-Demand over Satellite. *IST-Africa 2007 Conference, Maputo, Mozambique, 9-11 May 2007*.

S

Saidi M. 2007. Developing a systems analytical framework for the National Poverty Alleviation System (NPAS): the Community Based Public Works Programme (CBPWP) case study. *CIB World Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007*.

Saidi M. 2007. Developing a systems framework for Sustainable Infrastructure Technologies (SIT) in the built environment focussing on health facilities: a case for Cape Town. *CIB World Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007*.

Saidi M. 2007. Developing a user-perception assessment tool for health facilities in South Africa. *2nd Built Environment Conference, Cape Town, South Africa, 17-19 June 2007*.

Schaffers H, Cordoba MG, Hongisto P, Kallai T, Merz C, Van Rensburg JF. 2007. Exploring business models for open innovation in rural living labs. *13th International Conference on Concurrent Enterprising, Sophia-Antipolis, France, 4-6 June 2007*.

Schmitz PMU, Scheepers L, de Wit PWC, De la Rey A. 2007. Understanding data supply chains by using the supply-chain operations reference (SCOR) model. *Logistics Research Network Annual Conference, Hull, United Kingdom, 5-7 September 2007*.

Scholes MC, De Villiers S, Scholes RJ, Feig G. 2007. Integrated approach to nutrient cycling monitoring. *South African Journal of Science*, 103, p.323-328.

Scholes RJ, Biggs R, Brown-Gaddis EJ, Holl KD. 2007. Overcoming obstacles at a global scale to restore natural capital. In: Aronson J, Milton SJ, Blignaut JN (eds.). *Restoring Natural Capital: Science, Business and Practice*, p.20-32.

Scholes RJ. 2007. What do we need to know about biodiversity, and how can we find it out? *Norway/UN Conference on Ecosystems and People: Biodiversity for Development: the Road to 2010 and Beyond, Trondheim, Norway, 29 October-2 November 2007*.

Schutte PC, James JP. 2007. Ergonomics. In: Stanton DW, Kielblock J, Schoeman JJ, Johnston JR (eds.). *Handbook on Mine Occupational Hygiene Measurements*, p. 40-52.

Schwering PBW, Bezuidenhout DF, Gunter WH, De Jong AN, Fritz PJ, Le Roux FPJ, Sieberhagen RH, Holloway M, Vrahimis G, October FJ, Kemp RAW. 2007. Optical characterisation of small surface targets. *SPIE Europe Optics & Photonics in Security & Defence 2007, Florence, Italy, 17-20 September 2007*.

Scott L, Woodborne SM. 2007. Pollen analysis and dating of Late Quaternary faecal deposits (hyraceum) in the Cederberg, Western Cape, South Africa. *Review of Palaeobotany & Palynology*, 144(3-4), p.123-137.

Scott L, Woodborne SM. 2007. Vegetation history inferred from pollen in Late Quaternary faecal deposits (hyraceum) in the Cape winter-rain region, and its bearing on past climates in South Africa. *Quaternary Science Reviews*, 26(7-8), p.941-953.

Sebake TN, Mphutlane LG, Gibberd JT. 2007. Developing a school infrastructure performance indicator system (SIPIS). *2nd Built Environment Conference, Port Elizabeth, South Africa, 17-19 June 2007*.

Seleka TS, Pityana SL, Ulbrich M, Rampedi DL. 2007. Quantitative analysis of retained austenite in laser melted martensitic stainless steel. *ICALEO 2007: 26th International Congress on Applications of Lasers and Electro-optics, Orlando, Florida, U.S.A., 29 October-1 November 2007*.

Shaik AA, Bright G, Xu WL. 2007. Mechatronic sensor system for robots and automated machines. *International Conference on Competitive Manufacturing (COMA 2007), Stellenbosch, South Africa, 31 January-2 February 2007*.

Shaik AA, Bright G, Xu WL. 2007. Sensor system for multi axis automated assembly and manufacturing machines. *IEEE International Symposium on Assembly and Manufacturing, Ann Arbor, Michigan, U.S.A., 22-25 July 2007*.

Shatalov MY, Joubert SV, Coetzee CE, Fedotov I. 2007. Gyroscopic effects in vibrating fluid-filled spheres subjected to inertial rotation. *14th International Congress on Sound and Vibration (ICSV14), Cairns, Australia, 9-12 July 2007*.

Shatalov MY, Joubert SV, Voges E. 2007. Investigation of gyroscopic effects in vibrating fluid-filled cylinders subjected to axial rotation. *14th International Congress on Sound and Vibration (ICSV14), Cairns, Australia, 9-12 July 2007*.

Shatalov MY, Lunin BS. 2007. Vibratory gyroscopes: identification of mathematical model from test data. *14th International Conference on Integrated Navigational Systems (ICINS), St.Petersburg, Russia, 28-30 May 2007*.

Sherwill T, Van Wyk E, Arendse LI, Sihlope N, Zeka S, Rogers K, Van Wilgen BW. 2007. Stakeholder connectedness and participatory water resource management in South Africa. *Water SA*, 33(4), p.505-512.

Simpson C, Jordaan J, Gardiner NS, Whiteley C. 2007. Isolation, purification and characterization of a novel glucose oxidase from *Penicillium* sp. CBS 120262 optimally active at neutral pH. *Protein Expression and Purification*, 51(2), p.260-6.

Singh N, Kataka MO, Milev AM, Sellers EJ. 2007. Remnant mining in South African gold mines. In: Potvin Y, Hadjigeoegiu D, Stacey D (eds.). *Challenges in Deep and High Stress Mining*, p.17-24.

Singh S, Ray SS. 2007. Polylactide based nanostructured biomaterials and their applications. *Journal of Nanoscience and Nanotechnology*, 7(8), p.2596-2615.

Sivakumar V. 2007. De-noising LiDAR signal using wavelet technique. *SPIE Optics and Photonics 2007: Lidar Remote Sensing for Environmental Monitoring VIII, San Diego, California, U.S.A., 26-30 August 2007*.

Sivakumar V, Portafaix T, Bencherif H, Godin-Beekmann S, Baldy S. 2007. Stratospheric ozone climatology and variability over a southern subtropical site: Reunion Island (21°S; 55°E). *Annales Geophysicae*, 25(12), p.2321-2334.

Smith A. 2007. Intelligent physical blocks for introducing computer programming in developing countries. *IST-Africa 2007 Conference, Maputo, Mozambique, 9-11 May 2007*.

Smith A C. 2007. Using magnets in physical blocks that behave as programming objects. *1st International Conference on Tangible and Embedded Interaction, Baton Rouge, Louisiana, U.S.A., 15-17 February 2007.*

Smith-Adao LB, Scheepers ACT. 2007. An assessment of the channel morphological changes in the Lourens River, Western Cape. *Water SA*, 33(4), p.559-570.

Smith P, Martino D, Cai Z, Gwary D, Janzen H, Kumar P, McCarl B, Ogle S, O'Mara F, Rice C, Scholes RJ, Sirotenko O, Howden M, McAllister T, Pan G, Romanenkov V, Schneider U, Towprayoon S. 2007. Policy and technological constraints to implementation of greenhouse gas mitigation options in agriculture. *Agriculture, Ecosystems and Environment*, 118, p.6-28.

Snedden CL, Roux CZ, Verryn SD. 2007. Broad and narrow sense heritabilities in a South-African cloned open-pollinated *Eucalyptus grandis* breeding population. *Southern Hemisphere Forestry Journal*, 69(2), p.81-90.

Snedden CL, Verryn SD, Norris C, Thompson I. 2007. Early evaluation of growth properties and discussion of deployment options of hybrids with *E. longirostrata* for the South African pulp industry. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Snedden GC, Roos TH, Dunn D, Gregory-Smith D. 2007. Characterisation of a refurbished 1½ stage turbine test rig for flowfield mapping behind blading with non-axisymmetric contoured endwalls. *ISABE Conference, Beijing, China, 2-7 September 2007.*

Snow GC, Taljaard S. 2007. Water quality in South African temporarily open/closed estuaries: a conceptual model. *African Journal of Aquatic Science*, 32(2), p.99-111.

Snyman IM, Mostert FJ. 2007. Analysis of the South African surrogate for a TMRP-6 anti-tank mine. *23rd International Symposium on Ballistics, Tarragona, Spain, 16-20 April 2007.*

Sokoya OA, Maharaj BT. 2007. Performance of super-orthogonal space-time trellis code in a multipath environment. *IEEE Africon 2007, Windhoek, Namibia, 26-28 September 2007.*

Somerset VS, Klink MJ, Baker PGL, Iwuoha EI. 2007. Acetylcholinesterase-polyaniline biosensor investigation of organophosphate pesticides in selected organic solvents. *Journal of Environmental Science and Health B*, 42(3), p.297-304.

Somerset VS, Klink M, Akinyeye R, Michira I, Sekota M, Al-Ahmed A, Baker P, Iwuoha E. 2007. Spectroelectrochemical reactivities of novel polyaniline nanotube pesticide biosensors. *Macromolecular Symposia*, 255(1), p.36-49.

Soukupova V, Boguslavsky LD, Anandjiwala RD. 2007. Studies on the properties of biodegradable wipes made by the hydroentanglement bonding technique. *Textile Research Journal*, 77(5), p.301-311.

Sowden M, Zunckel M, Van Tienhoven AM. 2007. Assessment of the status of biogenic organic emissions and impacts on air quality in southern Africa. *Tellus B*, 59(5), p.535-541.

Sowden M, Naidoo M. 2007. Estimating photochemical emission inventories using GIS and MODIS data for South Africa. *14th IUAPPA World Clean Air and Environmental Protection Congress, Brisbane, Australia, 9-13 September 2007.*

Ssamula B. 2007. Hub network design for sparse travel demand within the African aviation industry. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Steyn J, Naidoo K, Land KJ. 2007. Improvement of the surface finish obtained by laser ablation with a Nd: YAG laser on pre-ablated tool steel. *International Conference on Competitive Manufacturing (COMA 07), Stellenbosch, South Africa, 31 January-2 February 2007.*

Steyn WJVDM, Sadzik E. 2007. Application of the portable pavement seismic analyser (PSPA) for pavement analysis. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Steyn WJVDM. 2007. Applications of observational techniques in pavement engineering. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Strydom WF, Hill L, Eloff E. 2007. The role of communication in governance: the River Health Programme as a case study. In: Turton AR, Hattingh HJ, Maree GA, Roux DJ, Claassen M, Strydom WF (eds.). *Governance as a Trialogue: Government-Society-Science in Transition,* p.281-301.

Taute BJE. 2007. Integrated control of the South African border environment. *South African Joint Air Defence Symposium 2007, Pretoria, South Africa, 30-31 May 2007.*

Teske PR, Papadopoulos I, McQuaid CD, Newman BK, Barker NP. 2007. Climate change, genetics or human choice: why were the shells of mankind's earliest ornament larger in the Pleistocene than in the Holocene? *PLoS ONE*, 7, p.1-5.

T

Theron M, Van Rooyen C, Ivanchev LH. 2007. CW Nd:YAG laser welding of dissimilar sheet metals. *ICALEO 2007: 26th International Congress on Applications of Lasers and Electro-optics, Orlando, Florida, U.S.A., 29 October-1 November 2007.*

Theyse HL, Maina JW, Kannemeyer L. 2007. Revision of the South African flexible pavement design method; mechanistic-empirical components. *9th Conference on Asphalt Pavements for Southern Africa (CAPSA), Gaborone, Botswana, 2-5 September 2007.*

Theyse HL, Legge FTH, Pretorius PC, Wolff H. 2007. A yield strength model for partially saturated unbound granular material. *Road Materials and Pavement Design*, 8(3), p.423-448.

Tredoux G, Van Der Merwe B, Peters I, Louw DR. 2007. Water quality aspects of artificial groundwater recharge at Windhoek. *6th International Symposium on Managed Artificial Recharge of Groundwater (ISMAR6), Phoenix, Arizona, U.S.A., 28 October-2 November 2007.*

Turton AR, Hattingh J, Maree GA, Roux DJ, Claassen M, Strydom WF. 2007. *Governance as a Trialogue: Government-Society-Science in Transition,* 400pp.

Turton AR. 2007. The hydropolitics of cooperation: South Africa during the Cold War. In: Grover VI (ed.). *Water: a Source of Conflict or Cooperation?* p.30-49.

Turton AR, Hattingh J, Claassen M, Roux DJ, Ashton PJ. 2007. Towards a model for ecosystem governance: an integrated water resource management example. In: Turton AR, Hattingh HJ, Maree GA, Roux DJ, Claassen M, Strydom WF (eds.). *Governance as a Trialogue: Government-Society-Science in Transition,* p.2-28.

Turton AR, Hattingh J. 2007. The trialogue revisited: quo vadis governance? In: Turton AR, Hattingh HJ, Maree GA, Roux DJ, Claassen M, Strydom WF (eds.). *Governance as a Trialogue: Government-Society-Science in Transition,* p.337-350.

U

Udahemuka G, Van Den Bergh F, Van Wyk MA. 2007. Robust fitting of diurnal brightness temperature cycle. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Umuhoza D, Agbinya JI, Omlin CW. 2007. Estimation of trust metrics for MANET using QoS parameter and source routing algorithms. *2nd Australian Conference on Wireless Broadband and Ultra Wideband Communications, Sydney, Australia, 27-30 August 2007.*

V

Van Aardt, JAN, Wynne RH. 2007. Examining pine spectral separability using hyperspectral data from an airborne sensor: an extension of field-based results. *International Journal of Remote Sensing*, 28(2), p.431-436.

Van den Berg M, Aucamp FN. 2007. A practical look at results from two mobile learning pilots in South Africa. *IST-Africa Conference, Maputo, Mozambique, 9-11 May 2007.*

Van den Bergh F, Van Wyk MA, Van Wyk BJ, Udahemuka G. 2007. A comparison of data-driven and model-driven approaches to brightness temperature diurnal cycle interpolation. *SAIEE Africa Research Journal*, 98(3), p.81-86.

Van den Bergh F, Brits R, Engelbrecht AP. 2007. Locating multiple optima using particle swarm optimization. *Applied Mathematics and Computation*, 189(2), p.1859-1883.

Van der Merwe A, Kotze P, Gerber AJ. 2007. Generic process model structures: towards a standard notation for abstract representations. *Annual Conference of the South African Institute of Computer Scientists and Information Technologists (SAICSIT 2007), Fish River Sun, Sunshine Coast, South Africa, 30 September-3 October 2007.*

Van der Plas AK, Monteiro PMS, Pascall A. 2007. Cross-shelf biogeochemical characteristics of sediments in the central Benguela and their relationship to overlying water column hypoxia. *African Journal of Marine Science*, 29(1), p.37-47.

Van der Walt CM, Barnard E. 2007. Data characteristics that determine classifier performance. *SAIEE Africa Research Journal*, 98(3), p.87-93.

Van der Walt CM, Barnard E. 2007. Measures for the characterisation of pattern-recognition data sets. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Van der Westhuizen CW, Rousseau AL, Parkinson CJ. 2007. Effect of substituent structure on pyrimidine electrophilic substitution. *Tetrahedron*, 63(25), p.5394-5405.

Van Dyk E, Barnard E. 2007. Naive Bayesian classifiers for multinomial features: a theoretical analysis. *PRASA 2007: 28th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Van Heerden CJ, Barnard E. 2007. Durations of context-dependent phonemes: a new feature in speaker verification. In: Muller C. (ed.). *Speaker Classification II,* p.93-103.

Van Heerden CJ, Barnard E. 2007. Speaker-specific variability of phoneme durations. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Van Heerden CJ, Barnard E. 2007. Speech rate normalization used to improve speaker verification. *SAIEE Africa Research Journal*, 98(4), p.129-135.

Van Heerden FR, Horak RM, Maharaj VJ, Vleggaar R, Senabe JV, Gunning PJ. 2007. An appetite suppressant from *Hoodia* species. *Phytochemistry*, 68(20), p.2545-2553.

Van Jaarsveld AS, Pauw JC, Mundree S, Mecenero S, Coetzee BWT, Alard GF. 2007. South African Environmental Observation Network: vision, design and status. *South African Journal of Science*, 103, p.289-294.

Van Niekerk DR, Barnard E. 2007. Important factors in HMM-based phonetic segmentation. *PRASA 2007: 18th Annual Symposium of the Pattern Recognition Association of South Africa, Pietermaritzburg, Kwazulu-Natal, South Africa, 28-30 November 2007.*

Van Rensburg JF, Smit D, Veldsman AW. 2007. Marrying the 'System of Innovation' and micro enterprises in real world rural SADC: an overview of collaborative SMME incubation in the Rural Living Lab of Sekhukhune. *IST-Africa 2007 Conference, Maputo, Mozambique, 9-11 May 2007.*

Van Schoor AM, Fourie S. 2007. Integrated geophysics at #4, 13th Avenue. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Van Schoor AM, Fourie S. 2007. The use of physical scale modelling to predict in-mine geophysical responses. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Van Wilgen BW, Govender N, Biggs HC. 2007. The contribution of fire research to fire management: a critical review of a long-term experiment in the Kruger National Park, South Africa. *International Journal of Wildland Fire*, 16(5), p.519-530.

Van Wilgen BW, Nel JL, Rouget M. 2007. Invasive alien plants and South African rivers: a proposed approach to the prioritisation of control operations. *Freshwater Biology*, 52, p.711-723.

Van Wyk BJ, Van Wyk MA, Van Den Bergh F. 2007. A note on difference spectra for fast extraction of global image information. *SAIEE Africa Research Journal*, 98(2), p.66-67.

Van Wyk E, Breen CM, Sherwill T, Magadlela D. 2007. Challenges for the relationship between science and society: developing capacity for ecosystem governance in an emerging democracy. *Water Policy*, 9(S2), p.177-189.

Van Wyk LV. 2007. Construction contractors and healthcare delivery in South Africa: challenges and interventions. *South African Federation of Hospital Engineering (SAFHE) and Clinical Engineering Association of South Africa (CEASA) 2007 National Biennial Conference and Exhibition: African Solutions to Integrated Healthcare, Port Elizabeth, South Africa, 17-19 October 2007.*

Van Wyk LV, Knoetze TP. 2007. Defining a strategic national agenda on the theory of construction for development. *CIB World Building Congress: Construction for Development, Cape Town, South Africa, 14-18 May 2007.*

Vaudreuil S, Labzour A, Sinha-Ray S, El Mabrouk K, Bousmina M. 2007. Dispersion characteristics and properties of poly(methyl methacrylate)/multi-walled carbon nanotubes nanocomposites. *Journal of Nanoscience and Nanotechnology*, 7(7), p.2349-2355.

Veerasamy N, Eloff JP. 2007. Framework for the establishment of a Honeynet. *Southern African Telecommunication Networks and Applications Conference (SATNAC 2007), Mauritius, 9-13 September 2007.*

Veerasamy N, Cheyne CJ. 2007. Stealthy network transfer of data. *International Conference on Computer, Electrical, and Systems Science, and Engineering (CESSE 2007), Venice, Italy, 23-25 November 2007.*

Velupillai HM, Van Heerden RP, Vorster J. 2007. Implementing honeypots as part of a simple cost effective wireless intrusion detection system. *Southern African Telecommunication Networks and Applications Conference (SATNAC 2007), Mauritius, 9-13 September 2007.*

Venter CJ, Mashiri MAM. 2007. Gender and transport: towards a practical analysis framework for improved planning. *SATC 2007: 26th Annual Southern African Transport Conference and Exhibition: The Challenges of Implementing Policy?, Pretoria, South Africa, 9-12 July 2007.*

Venter HM, Sivlal A. 2007. Fluorescence microscopy study of the effect of TVP, OSP and AIP cross pollination techniques on successful pollen germination on the stigma. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Venter JP, Van Waveren CC. 2007. New product development with dynamic decision support. *PICMET 2007 Conference, Portland, Oregon, U.S.A., 5-9 August 2007.*

Venter JP, De Waal A, Willers N. 2007. Specializing CRISP-DM for evidence mining. In: Graiger P, Shenoi S (eds.). *Advances in Digital Forensics III*, p.303-315.

Verbesselt J, Somers B, Lhermitte S, Jonckheere I, Van Aardt, JAN, Coppin P. 2007. Monitoring herbaceous fuel moisture content with SPOT VEGETATION time-series for fire risk prediction in savanna ecosystems. *Remote Sensing of Environment*, 108(4), p.357-368.

Verhaeghe BMJA, Myburgh PA, Denneman E. 2007. Asphalt rutting and its prevention. *9th Conference on Asphalt Pavements for Southern Africa (CAPSA), Gaborone, Botswana, 2-5 September 2007.*

Verryn SD, Snedden CL, Eatwell KA. 2007. A comparison of deterministically predicted genetic gains with those realised in *E. grandis* breeding. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and Diversity: Balancing Productivity and Sustainability, Durban, South Africa, 24-26 October 2007.*

Vlok JD, Linde LP. 2007. Performance of sparse graph codes on a four-dimensional CDMA System in AWGN and multipath fading. *IEEE Africon 2007, Windhoek, Namibia, 26-28 September 2007.*

Vogt DR, Nyareli TN. 2007. Experimentally achieving borehole radar antenna directivity in the time domain in the presence of strong mutual coupling. *South African Geophysical Association 10th Biennial Conference & Exhibition: Making Waves, Wild Coast Sun, South Africa, 22-26 October 2007.*

Von Bergmann H, Forbes A, Roberts DE, Botha LR. 2007. Influence of acoustic waves on TEA CO_2 laser performance. *XVI International Symposium on Gas Flow, Chemical Lasers, and High-Power Lasers, Austria, 4-8 August 2006.*

W

Wakelyn PJ, Bertoniere NR, French AD, Thibodeaux DP, Triplett BA, Rousselle M-A, Goynes WR, Edwards JV, Hunter L, McAlister DD, Gamble GR. 2007. *Cotton Fiber Chemistry and Technology*, 176pp.

Wall K. 2007. The benefits of franchising in improving SA's water services delivery. In: Dominy S (ed.). *South Africa's top performing companies,* 7th edition, p.4.

Wall K. 2007. Challenges facing municipal infrastructural management in South Africa. *Town and Regional Planning*, 51, p.26-36.

Wall K, Milford RV, Kubuzie M. 2007. The national infrastructure maintenance strategy. *71st Institute of Municipal Engineering of Southern Africa (IMESA) Conference: Sustainable Municipal Engineering 2010 and Beyond, Durban, South Africa, 23-26 October 2007.*

Wallington BP, McKechnie AE, Owen-Smith N, Woodborne S. 2007. Stable carbon isotope analysis of eland (*Taurotragus oryx*) diet in the Suikerbosrand Nature Reserve. *South African Journal of Wildlife Research*, 37(2), p.127-131.

Walwyn DR. 2007. Finland and the mobile phone industry: a case study of the return on investment from government-funded research and development. *Technovation*, 27, p.335-341.

Watkeys M, Kretzinger W, Perritt SH, Jokat W, Ovechkina M. 2007. Manganese deposits on the Mozambique ridge, SW Indian Ocean. *5th Annual Inkaba yeAfrica Workshop at the 2007 (SAGA) Biennial Conference, Wild Coast Sun, Eastern Cape Province, South Africa, 22-26 October 2007.*

Wessels KJ, Prince SD, Malherbe J, Small J, Frost PE, Van Zyl D. 2007. Can human-induced land degradation be distinguished from the effects of rainfall variability? A case study in South Africa. *Journal of Arid Environments*, 68, p.271-297.

Wessels KJ, Prince SD. 2007. Monitoring desertification's impact on vegetation production in South Africa using long-term AVHRR and MODIS data: a test of the non-equilibrium rangeland theory. *32nd International Symposium on Remote Sensing of the Environment, San Jose, Costa Rica, 25-29 June 2007.*

Wessels KJ, Prince S. 2007. Monitoring land degradation with long-term satellite data in South Africa. In: Nicklin S, Cornwell B, Dodd J, Griffiths J (eds.). *The full picture*, p.240-242.

Wessels KJ, Prince SD, Carroll M, Malherbe J. 2007. Relevance of rangeland degradation in semiarid Northeastern South Africa to the nonequilibrium theory. *Ecological Applications*, 17(3), p.815-827.

West NJ, Jandrell IR, Forbes A. 2007. Preliminary investigation into the simulation of a laser-induced plasma by means of a floating object in a spark gap. *XVth International Symposium on High Voltage Engineering, University of Ljubljana, Ljubljana, Slovenia, 27-31 August 2007.*

Willers CJ, Wheeler MS. 2007. The validation of models in an imaging infrared simulation. *International Microwave and Optoelectronics Conference (IMOC), Salvador, Brazil, 29 October-1 November 2007.*

Wilson KA, Underwood EC, Morrison SA, Klausmeyer KR, Murdoch WW, Reyers B, Wardell-Johnson G, Marquet PA, Rundel PW, McBride MF, Pressey RL, Bode M, Hoekstra JM, Andelman S, Looker M, Rondinini C, Kareiva P, Shaw MR, Possingham HP. 2007. Conserving biodiversity efficiently: what to do, where, and when. *PLoS Biology*, 5(9), p.1850-1861.

Wise RM, Cacho O, Hean R. 2007. Fertilizer effects on the sustainability and profitability of agroforestry in the presence of carbon payments. *Environmental Modelling and Software*, 22(9), p.1372-1381.

Wright A, Burns M. 2007. Trade-offs: what to choose and what to lose. In: Govender K, Adouin M (eds.). *Enhancing the Effectiveness of SEA in South Africa*, p.1-20.

X

Xing B, Gao W, Tlale NS, Bright G. 2007. Design and application of reconfigurable manufacturing systems in agile mass customization manufacturing environment. *International Conference on Industrial Engineering and Systems Management (IESM 2007), Beijing, China, 30 May-2 June 2007.*

Xing B, Bright G, Tlale NS. 2007. Modular mechatronic control of reconfigurable manufacturing system for mass customization manufacturing. *International Conference on Competitive Manufacturing (COMA 2007), Stellenbosch, South Africa, 31 January-2 February 2007.*

Xing B, Bright G, Tlale NS. 2007. Reconfigurable manufacturing systems for mass producing custom product. *23rd ISPE International Conference on CAD/CAM Robotics and Factories of the Future, Bogota, Colombia, 16-18 August 2007.*

Y

Yeates CA, Smit MS, Botes AL, Breytenbach JC, Krieg HM. 2007. Optimisation of the biocatalytic resolution of styrene oxide by whole cells of *Rhodotorula glutinis*. *Enzyme and Microbial Technology*, 40(2), p.221-227.

Z

Zbonak A, Bush TLD, Grzeskowiak V. 2007. Comparison of tree growth, wood density and anatomical properties between coppiced trees and parent crop of six *Eucalyptus* genotypes. *IUFRO Working Group 2.08.03 Improvement and Culture of Eucalypts. Eucalypts and diversity: Balancing Productivity and Sustainability, Durban, South Africa, 22-26 October 2007.*

Zbonak A, Bush TLD. 2007. Wood and pulp properties of coppiced trees after first rotation related to their parent crop in six *Eucalyptus* gentotypes. *South African Journal of Botany*, 73(2), p.322-323.

Zheltov GI, Astafyeva LG, Karsten A. 2007. Physical model of laser-assisted blocking of blood flow, I: rectangular radiation pulses. *Optics and Spectroscopy*, 102(3), p.469-474.

Zheltov GI, Astafyeva LG, Karsten A. 2007. Physical model of laser-assisted blocking of blood flow, II: pulse modulation of radiation. *Optics and Spectroscopy*, 102(3), p.475-477.

Zhuang ZQ, Pagnucco M, Meyer T. 2007. Implementing iterated belief change via prime implicates. *20th Australian Joint Conference on Artificial Intelligence: Advances in Artificial Intelligence, Gold Coast, Australia, 2-6 December 2007.*

Zunckel M, Chiloane EK, Sowden M, Otter L. 2007. Biogenic volatile organic compounds (BVOCs): the state of knowledge in southern Africa and the challenges for air quality management. *South African Journal of Science*, 103(3/4), p.107-112.

Corporate Governance

Framework

Corporate governance is formally concerned with the organisational arrangements that have been put in place to provide an appropriate set of checks and balances within which the stewards of the organisation operate. The objective is to ensure that those to whom the stakeholders entrust the direction and success of the organisation act in the best interest of these stakeholders. It is about leadership with integrity, responsibility and transparency.

The CSIR is committed to principles and practices that will provide our stakeholders with the assurance that the organisation is managed soundly and ethically. We have established a management model that governs and provides guidance for the way that all employees – not only the leaders – interact with our various stakeholder groups.

The underpinning principles of the Group's corporate governance rest on the three cornerstones of an effective and efficient organisation, namely day-to-day management processes, a long-term strategic planning process and effective change processes. These processes are supported by systems that are used to plan, execute, monitor and control the strategic and operational domains of the organisation. The supporting infrastructure and its evolution are documented in our management model, which is reviewed and updated regularly.

In accordance with the Scientific Research Council Act, Act 46 of 1988, as amended by Act 71 of 1990, the appointment of the CSIR Board is by the executive authority. The Board provides strategic direction and leadership, determines goals and objectives of the CSIR, and approves key policies, including investment and risk management and reviews. It also approves financial objectives, plans, goals and strategies. The Board has adopted formal terms of reference that are in line with the Scientific Research Council Act and the Public Finance Management Act (PFMA), Act 1 of 1999, as amended by Act 29 of 1999.

The CSIR Board and the CSIR Executive Management Committee believe that the organisation has applied and complied with the principles incorporated in the Code of Corporate Practices and Conduct, as set out in the King II Report.

Shareholders Compact

In terms of the treasury regulations issued in accordance with the PFMA, the CSIR must, in consultation with the executive authority, annually agree on its key performance objectives, measures and indicators.

This is annexed in the shareholders performance agreement (Shareholders Compact) concluded between the CSIR Board and the executive authority.

The compact promotes good governance practices in the CSIR by helping to clarify the roles and responsibilities of the Board and the executive authority and ensuring agreement on the CSIR's mandate and key objectives.

Financial statements

The CSIR Board and the CSIR Executive Management Committee confirm that they are responsible for preparing financial statements that fairly present the state of affairs of the Group as at the end of the financial year and the results and cash flows for that period. The financial statements are prepared in accordance with South African Statements of Generally Accepted Accounting Practice (SA GAAP). In addition, the CSIR Board is satisfied that adequate accounting records have been maintained.

The external auditor is the Auditor-General, who is responsible for independently auditing and reporting on whether the financial statements are fairly presented in conformity with South African Statements of Generally Accepted Accounting Practice. The Auditor-General's terms of reference do not allow for any non-assurance work to be performed.

Risk management and internal control

In the case of risk management, the CSIR Board is accountable for the process of risk management and the systems of internal control. These are reviewed regularly for effectiveness. Appropriate risk and control policies are established and communicated throughout the organisation. The CSIR Board retains control through the final review of key risk matters affecting the organisation.

Risk management in the CSIR is an ongoing process, focused on identifying, assessing, managing and monitoring all known forms of significant risks across all operating units and Group companies. This has been in place for the year under review and up to the date of approval of the annual report and financial statements.

A structured process of risk management has been put in place to ensure that the growth and development of human capital, strengthening of the science, engineering and technology (SET) base, operational excellence and financial sustainability will be achieved over time.

CSIR systems have been put in place to review aspects of economy, efficiency and effectiveness. Management is involved in a continuous process of improving procedures to ensure effective mechanisms for identifying, managing and monitoring risks in the following major broad risk management areas: research; business; financial internal control; operational; fraud; physical; and environment, health and safety risk management.

Documented and tested processes are in place, which will allow the CSIR to continue its critical business process in the event of a disastrous incident impacting on its activities.

Research risk management

The Group recognises that research has to be conducted in compliance with the existing legal framework, aligned to CSIR strategies and in accordance with the standards and practices that would ensure outputs that support the CSIR's mandate.

To mitigate research-related risks, the CSIR has an established Good Research Guide and institutional governance structures such as the research and development (R&D) core management function, the Strategic Research Panel (SRP) and the Research Advisory Panels (RAPs). In addition, projects that require reviews from a research ethics perspective are submitted to the Research Ethics Committee of the University of Pretoria.

The CSIR is in the process of establishing its own ethics committee.

Business risk management

To ensure effective mechanisms are in place for identifying and monitoring risks that impact on the CSIR Group, the procedures for implementing the Group's business risk management process include a focus on human capital assessment and development, technological development, operations, business continuity, contracting, Parliamentary Grant investment, legislative requirements, professional liability, occupational health and safety, public safety and security, natural disasters and general operating risks.

Fraud risk management

The objective is to manage the fraud risk and to raise the level of fraud awareness amongst the CSIR's internal and external stakeholders. The CSIR's fraud prevention plan intends to reduce the risk of fraud and provide contingency plans that will protect the interests of the organisation. The proactive approach consists of the prevention, detection, reporting, communication and reaction to fraud.

Safety, occupational health and environmental management

The CSIR is committed to the promotion of environmental, health and safety principles and practices to create a safe and healthy environment for all and to meet the requirements of all relevant environments and health and safety legislation as a

minimum standard. This commitment is depicted in two ways: in the manner it serves business as a supplier of environmental management-related products, and in the way it demonstrates sound environmental performance at all CSIR sites.

Operating risk management

The CSIR endeavours to minimise operating risk by ensuring that the appropriate infrastructure, controls, systems and people are in place throughout the Group. Key practices employed in managing operating risk include segregation of duties, transaction approval frameworks, financial and management reporting and monitoring of metrics, which are designed to highlight positive or negative performance across a broad range of key performance indicators (KPIs). The Operations Committee, which comprises members of the executive, operating unit/centre executive directors and group managers, oversees all operational matters.

Financial risk management

Financial risks are managed within predetermined procedures and constraints as identified and detailed in the various policies and the setting of annual goals and objectives. Controls are designed to give assurance that assets are safeguarded and that liabilities and working capital are managed effectively. Organisational policies, procedures, structures and approval framework provide for segregation of duties and contain self-monitoring mechanisms. Compliance is measured through regular reporting against the business goals, internal audit checks and external audit verification.

Going concern

The CSIR Board has reviewed the Group's financial budgets for the period 1 April 2008 to 31 March 2009 and is satisfied that adequate resources exist to continue business for the foreseeable future. The CSIR Board confirms that there is no reason to believe the business will not be a going concern in the year ahead.

Approval framework

The CSIR Board has adopted an approval framework that governs the authorisation processes in the CSIR. It deals with, among others, the construction of strategic plans, development of operational plans and budgets, appointment of staff, approval of salaries and acquisition and disposal of assets. It also defines authority levels in relation to organisational positions.

Appropriate controls are in place to ensure compliance with the above framework. A comprehensive set of procedures exists to provide the necessary checks and balances for the economical, efficient and effective use of resources. The essence of this framework is that it is comprehensive, clear and unambiguous, and easy to assimilate and internalise.

Each subsidiary company's board of directors has adopted an approval framework, which mirrors that of the CSIR. All subsidiary companies are under the control of the CSIR Board and CSIR Executive Management Committee.

Internal control

The CSIR Board has ultimate responsibility for the system of internal controls. The key controls required to ensure the integrity and reliability of financial statements have been identified in conjunction with the internal auditors. Close cooperation with the internal auditors ensures adequate and efficient audit reviews of the proper functioning of these key controls.

The annual audit plan is based on the key financial risks to the organisation. The work programme that gives effect to the plan is reviewed by the Audit and Risk Committee and ratified or modified as required.

Employee participation

The CSIR strongly encourages effective and modern workplace practices and relationships to foster employee participation and work process involvement as a key practice at all levels in the organisation. Employee participation happens, for example, through self-directed quarterly staff sessions, formal induction programmes, technical and strategic focus groups and task teams.

Charter of ethics and organisational values

The CSIR Board and CSIR Executive Management Committee have approved and adopted a Charter of Ethics, which reflects the CSIR's commitment to a policy of fair dealing and integrity in conducting its operations. The charter, which incorporates the CSIR's Code of Conduct and links closely to its set of

values, requires all employees to maintain the highest ethical standards, ensuring that business practices are conducted in a manner which, in all reasonable circumstances, is beyond reproach. Monitoring ethical behaviour is devolved to unit level and transgressions are addressed by means of procedures detailed in the CSIR's Conditions of Service and the PFMA.

The Board is satisfied there has been compliance with the Charter of Ethics.

Governance structure

CSIR Board

The responsibilities of the Board are governed by the Scientific Research Council Act.

The Board approves the strategy, goals, operating policies and priorities for the organisation and monitors compliance with policies and achievement against objectives.

With the exception of the CEO of the CSIR, all members of the CSIR Board are non-executive. CSIR Board members are actively involved in and bring independent judgement to bear on Board deliberations and decisions.

The CSIR Board, of which the current number of members adheres to the statutory minimum requirements, meets quarterly. For the year under review, the Board met on 21 June 2007, 19 September 2007, 27 November 2007 and 14 February 2008. The Annual Financial Statements for the 2007/08 financial year were approved on 13 August 2008.

The CSIR Board has the following sub-committees: the Human Resources and Remuneration Committee, the Audit and Risk Committee and the Strategic Review Committee (see page 140). These committees are selected according to the skills sets required for the committees to fulfil their functions. For the 2007/08 year, the committees complied with their respective terms of reference.

Board member	Board meetings (4)	Audit and Risk Committee (2)	Human Resources and Remuneration Committee (4)	Strategic Review Committee (2)
Ms Nobusi Shikwane	4	2	4	
Professor Cheryl de la Rey	4		3	2
Dr Nomsa Dlamini	2		3	
Dr Nhlanhla Msomi	4		4	2
Dr Francis Petersen	3	2		0
Professor Mike Wingfield	4			2
Mr Ebie Mayet	4	2		
Dr Sibusiso Sibisi	4	2	4	2
Professor Denis Hall	3			0
Professor Brenda Gourley (resigned)	1			

Executive Management Committee

The Executive Management Committee has executive responsibility for the CSIR and consists of the CEO (Dr Sibusiso Sibisi); three Group Executive members: Operations (Dr Hoffie Maree), R&D Outcomes and Strategic Human Capital Development (Khungeka Njobe), and R&D (Dr Thulani Dlamini, on an interim basis); Chief Financial Officer (Chris Sturdy) and Executive Director: Services (Raynold Zondo).

CSIR Leadership Team

The CSIR Management is responsible for strategy implementation and managing the day-to-day affairs of the CSIR and its operating units in accordance with the policies and objectives approved by the CSIR Board. This Leadership Team comprises the members of the CSIR Executive Management Committee, Group/Portfolio Managers, and Operating Unit Executive Directors and Centre Managers.

Other internal structures that contribute to governance at the CSIR include the Executive, Operations and Service Committees, the Strategic Research and Contract R&D Forums, and the RAPs.

Board of directors of group companies

The CSIR Executive has control over the boards of the various subsidiary companies.

Board and executive management remuneration

Details of the CSIR Board are set out on page 139 of the Corporate Governance Report. The membership and terms of reference of each Board Committee are further described on page 140 of the Corporate Governance Report.

Remuneration to Board Members and the Executive Management is set out in Note 19 to the Annual Financial Statements.

General

The CSIR acknowledges that systems of corporate governance should be reviewed continuously to ensure that these are sound and consistent with world-class standards relevant to the operations of the Group and the evolution thereof.

We shall continue to comply with all major recommendations of the Code of Corporate Practices and Conduct as set out in the King II Report on Corporate Governance.

Public Finance Management Act

The PFMA came into effect on 1 April 2000 and has had an impact on governance matters in terms of the regulation of financial management in the public sector. The Group complies, in all material aspects, with the Act.

Materiality framework

The materiality framework for reporting losses through criminal conduct and irregular, fruitless and wasteful expenditure, as well as for significant transactions envisaged per section 54(2) of the PFMA, has been finalised and incorporated into the Shareholder's Compact. No significant losses through criminal conduct and irregular, fruitless and wasteful expenditure were identified as having been incurred during the year.

CSIR Board members

Ms Nobusi Shikwane
(Chairperson)
Chief Executive Officer
Tshenolitha Business Services

Professor Cheryl de la Rey
Chief Executive Officer
Council on Higher Education

Dr Nomsa Dlamini
Managing Director
Masifundisane Training and Development Projects

Professor Brenda Gourley
Vice-Chancellor
The Open University
(resigned)

Professor Denis Hall
Deputy Principal and
Pro-Vice-Chancellor
Heriot Watt University

Mr Ebie Mayet
Executive in CEO's office
arivia.kom

Dr Nhlanhla Msomi
Chief Executive Officer
Africa Vukani Investment Ventures

Dr Francis Petersen
Dean
Faculty of Engineering and the Built Environment, University of Cape Town

Professor Mike Wingfield
Director
Forestry and Agricultural Biotechnology Institute, University of Pretoria

Dr Sibusiso Sibisi
Chief Executive Officer
and President
CSIR

CSIR Executive

CSIR Executive members from the back (left) are Khungeka Njobe, Group Executive: R&D Outcomes and Strategic Human Capital Development; Raynold Zondo, Executive Director: Services; Chris Sturdy, Chief Financial Officer; Dr Sibusiso Sibisi, CSIR President and CEO; (front left) Dr Hoffie Maree, Group Executive: Operations; and Dr Thulani Dlamini, Interim Group Executive: R&D

CSIR Board committees
2007/08

Audit and Risk Committee

Chairperson: Mr Ebie Mayet

Members: Dr Francis Petersen
Ms Nobusi Shikwane
Dr Sibusiso Sibisi

Meetings: 12 June 2007
12 February 2008

Purpose: Deals with all matters prescribed by the regulations issued in terms of the PFMA. Reviews key risk matters affecting the organisation. Agrees on the scope and reviews the annual external audit plan and the work of the CSIR internal auditors. Acts in an unfettered way to understand the dynamics and performance of the organisation without restrictions. The Audit and Risk Committee has adopted formal terms of reference and is satisfied that it has complied with its responsibilities as set out in the terms of reference.

Human Resources and Remuneration Committee

Chairperson: Ms Nobusi Shikwane

Members: Professor Cheryl de la Rey
Dr Nomsa Dlamini
Dr Nhlanhla Msomi
Dr Sibusiso Sibisi

Meetings: 14 June 2007
19 September 2007
27 November 2007
20 February 2008

Purpose: Provides the vehicle for the CSIR Board to influence and control human resources and remuneration in the organisation. Determines human resources policy and strategy. Approves remuneration changes and bonus payments. In addition, it reviews the remuneration and expenses of the Executive Management. The terms of reference of the committee are in line with the King II Code on Corporate Governance and will be formally adopted in the foreseeable future.

Strategic Review Committee

Chairperson: Professor Cheryl de la Rey

Members: Dr Nhlanhla Msomi
Dr Francis Petersen
Professor Denis Hall
Professor Mike Wingfield
Dr Sibusiso Sibisi

Meetings: 14 June 2007
16 October 2007

Purpose: Provides guidance and advice on the long-term trajectory and composition of the CSIR's science and technology portfolio in the context of the needs of the country. Ensures that key innovation and research processes are conducted effectively and benchmarked against international best practice, and that research outputs, organisational climate and credibility remain congruent with the role and objectives of the institution.

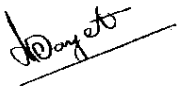
Report of the Audit Committee

REPORT OF THE AUDIT COMMITTEE REQUIRED BY TREASURY REGULATIONS 27.1.7 AND 27.1.10 (B AND C) OF THE PUBLIC FINANCE MANAGEMENT ACT, ACT I OF 1999, AS AMENDED BY ACT 29 OF 1999

The Audit Committee reports that it has adopted formal terms of reference as its Audit Committee Charter and that it has discharged all of its responsibilities for the year, in compliance with the charter.

The Audit Committee is satisfied that an adequate system of internal control is in place to reduce significant risks faced by the organisation to an acceptable level, and that these controls have been effective during the period under review. The system is designed to manage, rather than eliminate, the risk of failure and to maximise opportunities to achieve business objectives. This can provide only reasonable but not absolute assurance.

The Audit Committee has evaluated the Annual Financial Statements of the CSIR Group for the year ended 31 March 2008 and based on the information provided to the Audit Committee considers that it complies, in all material respects with the requirements of the various Acts and Standards governing disclosure and reporting on the Annual Financial Statements. The Audit Committee therefore recommends the adoption of the Annual Financial Statements by the Board of the CSIR.



Ebrahim Hassen Mayet
Chairperson
6 August 2008

Report of the Auditor-General

REPORT OF THE AUDITOR-GENERAL TO PARLIAMENT ON THE GROUP FINANCIAL STATEMENTS AND PERFORMANCE INFORMATION OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR) FOR THE YEAR ENDED 31 MARCH 2008.

REPORT ON THE FINANCIAL STATEMENTS

Introduction

1. I have audited the accompanying group financial statements of the CSIR which comprise the consolidated and separate balance sheet as at 31 March 2008, consolidated and separate income statement, consolidated and separate statement of changes in equity and consolidated and separate cash flow statement for the year then ended, and a summary of significant accounting policies and other explanatory notes, as set out on pages 156 to 199.

Responsibility of the accounting officer for the financial statements

2. The accounting officer is responsible for the preparation and fair presentation of these financial statements in accordance with the South African Statements of Generally Accepted Accounting Practice, as set out in accounting policy note 1 and in the manner required by the Public Finance Management Act, 1999 (Act 1 of 1999) (PFMA) and section 14(1) of the Scientific Research Council Act (Act 46 of 1988) as amended by Act 71 of 1990. This responsibility includes:

    - designing, implementing and maintaining internal control relevant to the preparation and fair presentation of financial statements that are free from material misstatement, whether due to fraud or error
    - selecting and applying appropriate accounting policies
    - making accounting estimates that are reasonable in the circumstances.

Responsibility of the Auditor-General

3. As required by section 188 of the Constitution of the Republic of South Africa, 1996 read with section 4 of the Public Audit Act, 2004 (Act 25 of 2004), my responsibility is to express an opinion on these financial statements based on my audit.

4. I conducted my audit in accordance with the International Standards on Auditing and General Notice 616 of 2008, issued in Government Gazette No 31057 of 15 May 2008. Those standards require that I comply with ethical requirements and plan and perform the audit to obtain reasonable assurance whether the financial statements are free from material misstatement.

5. An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.

6. An audit also includes evaluating the:
   - appropriateness of accounting policies used
   - reasonableness of accounting estimates made by management
   - overall presentation of the financial statements.

7. I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

Opinion

8. In my opinion the financial statements present fairly, in all material respects, the financial position of the CSIR and group as at 31 March 2008 and its financial performance and cash flows for the year then ended, in accordance with the South African Statements of Generally Accepted Accounting Practice, as set out in accounting policy note 1 and in the manner required by the PFMA.

OTHER MATTERS

Matters of governance

9. The PFMA tasks the accounting officer with a number of responsibilities concerning financial and risk management and internal control. Fundamental to achieving this is the implementation of certain key governance responsibilities, which I have assessed as follows:

Matter of governance	Yes	No
Audit committee		
The public entity has an audit committee.	✓	
The audit committee operates in accordance with approved written terms of reference.	✓	
The audit committee substantially fulfilled its responsibilities for the year, as set out in section 77 of the PFMA and Treasury Regulation 27.1.8.	✓	
Internal audit		
The public entity has an internal audit function.	✓	
The internal audit function operates in terms of an approved internal audit plan.	✓	
The internal audit function substantially fulfilled its responsibilities for the year, as set out in Treasury Regulation 27.2.	✓	
Other matters of governance		
The Annual Financial Statements were submitted for audit as per section 55 of the PFMA.	✓	
The financial statements submitted for audit were not subject to any material amendments resulting from the audit.	✓	
No significant difficulties were experienced during the audit concerning delays or the unavailability of expected information and/or the unavailability of senior management.	✓	
The prior year's external audit recommendations have been substantially implemented.	✓	

OTHER REPORTING RESPONSIBILITIES

Reporting on performance information

10. I have reviewed the performance information as set out on pages 148 to 155.

Responsibilities of the accounting officer

11. The accounting officer has additional responsibilities as required by section 55(2)(a) of the PFMA to ensure that the annual report and audited financial statements fairly present the performance against predetermined objectives of the public entity.

Responsibility of the Auditor-General

12. I conducted my engagement in accordance with section 13 of the Public Audit Act, 2004 (Act 25 of 2004) read with General Notice 616 of 2008, issued in Government Gazette No 31057 of 15 May 2008.

13. In terms of the foregoing my engagement included performing procedures of an audit nature to obtain sufficient appropriate evidence about the performance information and related systems, processes and procedures. The procedures selected depend on the auditor's judgment.

Audit findings (performance information)

14. I believe that the evidence I have obtained is sufficient and appropriate to report that no significant findings have been identified as a result of my review.

APPRECIATION

15. The assistance rendered by the staff of the CSIR during the audit is sincerely appreciated.

Auditor-General

Pretoria
18 July 2008

AUDITOR-GENERAL

Executive Report

Introduction

On behalf of the CSIR Board, we have pleasure in submitting to Parliament, through the Minister of Science and Technology, this report and the audited Annual Financial Statements of the CSIR Group for the year ended 31 March 2008.

In the opinion of the CSIR Board, which fulfils the role of directors as envisaged by the Companies Act, Act 61 of 1973, the financial statements fairly reflect the financial position of the CSIR Group as at 31 March 2008 and the results of its operations for the year then ended.

Our statutory basis

As a statutory research council established by government, the CSIR is governed by the Scientific Research Council Act, Act 46 of 1988, as amended by Act 71 of 1990. The organisation is listed as a Government Business Enterprise in terms of the PFMA, Act 1 of 1999, as amended by Act 29 of 1999.

Our income sources

CSIR activities are funded through a combination of baseline and ring-fenced grants from the Department of Science and Technology (DST), and contract research and development (R&D) income from local and international public and private sectors.

Our mandate

The CSIR's mandate is as stipulated in the Scientific Research Council Act, section 3: Objects of the CSIR:

"The objects of the CSIR are, through directed and particularly multi-disciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the improvement of the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act."

Alignment with the National R&D Strategy

The CSIR's research agenda responds through strategic technology development programmes established under the auspices of the National R&D Strategy, other key government strategies and the national development agenda that will promote human capital development (HCD) and economic growth.

While the intent of the National R&D Strategy is to achieve significant overall increases in the quantity of R&D funded and performed in South Africa, the national shortage of highly qualified scientific and engineering postgraduates remains a cause for concern. Over the past year, increasing competition has been experienced for talented individuals.

Lack of resources could compromise achievement of the desired national activity in research efforts. Contributing to national HCD at postgraduate level therefore remains a critical priority that is factored into the CSIR's planning. To this end, we are pleased to report that a formal HCD strategy has been put in place for the CSIR.

Institutionalising strategy

The CSIR's organisational priorities have remained consistent over the past few years. This has allowed for cumulative performance and proper entrenchment and institutionalising of strategy and objectives. Key elements of the strategy remain the strengthening of the science base and contributing science and technology (S&T) outputs in support of sustainable socio-economic development.

The CSIR will, therefore, remain active in other national strategies in addition to the National R&D Strategy, including the DST's 10-year Innovation Plan and the National Industrial Policy Framework in support of the Accelerated and Shared Growth Initiative for South Africa (AsgiSA).

Also shaping the CSIR's external operating environment is the Technology Innovation Agency (TIA) – an important development in the South African National System of Innovation (NSI), which will create opportunities to bridge the 'innovation chasm'.

The CSIR has made a commitment to assist with the establishment of the TIA in partnership with the DST.

The CSIR delivers its R&D output, in line with its strategy, through the following entities:

Category	Entity
CSIR operating units	• Biosciences • Built Environment • Defence, Peace, Safety and Security • Materials Science and Manufacturing • Natural Resources and the Environment • Modelling and Digital Science* • Information and Communications Technology (Meraka Institute)*
CSIR national centres	• National Laser Centre • Satellite Applications Centre
CSIR implementation units	• Consulting and Analytical Services • Enterprise Creation for Development**
CSIR emerging research areas	• Mobile Intelligent Autonomous Systems • Nanoscience • Synthetic Biology

*This new operating unit is being established in 2008/09

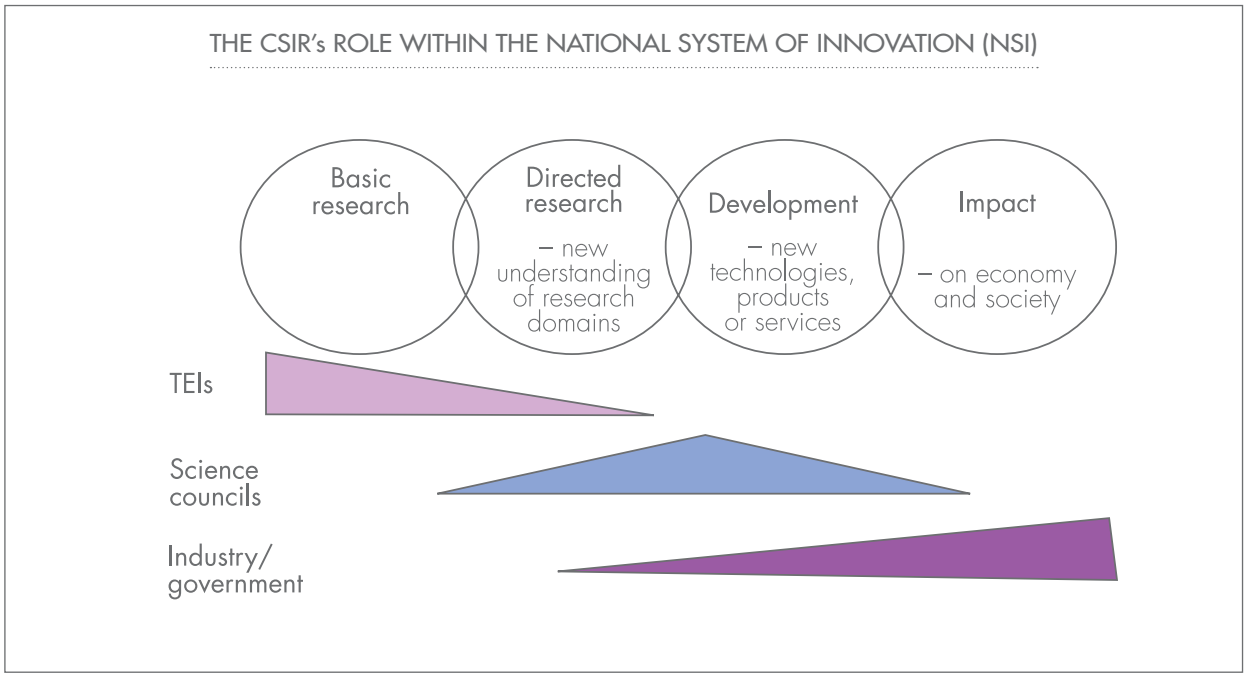
**Unit name to be finalised

Increased contribution to socio-economic development

The CSIR plays an increasingly important role in support of sustainable socio-economic development in South Africa in fulfilling its mandate, by making science and technology of the highest quality available to markets and society.

The design and establishment of strategic research programmes that address stakeholder requirements and produce a strong flow of new knowledge and technology, help to effect significant impact.

To ensure a balanced CSIR research portfolio, a new thematic programme was established with a focus on funding Type B research – experimental development leading to technology demonstrators. Of the more than 30 proposals received, four were selected to participate in this programme. The CSIR continues to conduct research across the R&D value chain (see diagram opposite).



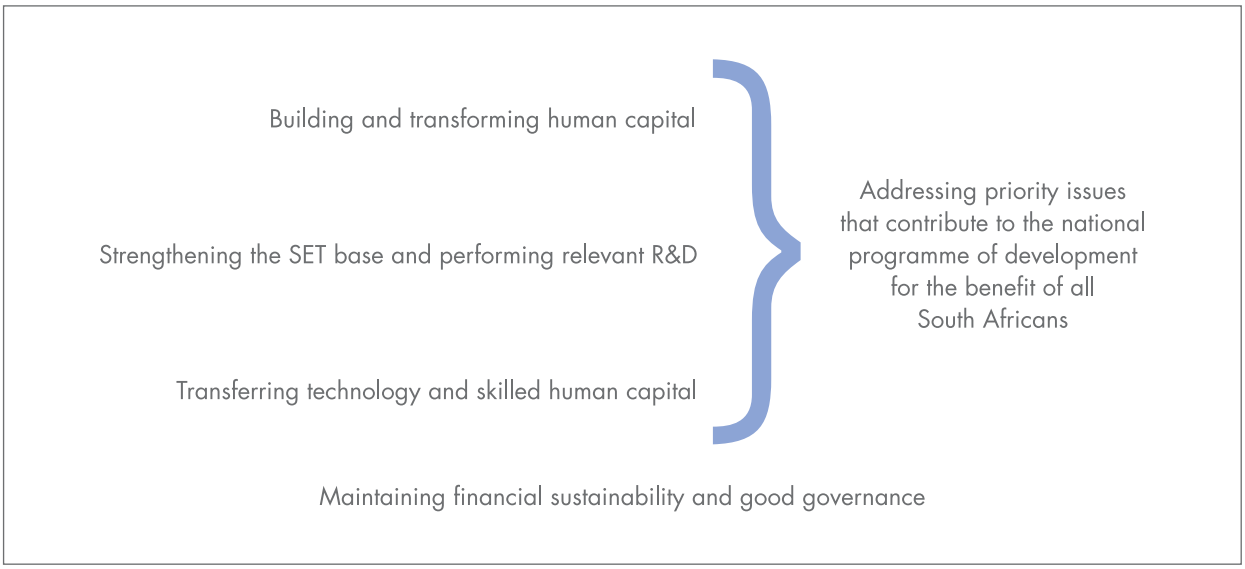
The CSIR spans the research and innovation value chain and focuses on its role, which is different to that of universities and commercial R&D bodies.

Our imperatives

The CSIR's strategy for 2007/08 translates into organisational priorities.

Performance is measured both quantitatively and qualitatively.

In response to and against the backdrop of broader national R&D obligations and expectations, the CSIR's strategic priorities are as follows:



The following pages outline the parameters within which the CSIR focuses its operations.

Building and transforming human capital

Priority area		Main and supporting KPIs	2007/08 Target	2007/08 Actual
Human capital development (HCD)	Quantity: number of full-time students supported financially	Number of full-time postgraduate students supported by the CSIR	93	222
		Number of postdoctorates	26	24
	Quality: profile of our researchers	Number of staff in SET base with PhD-level qualifications	242	234
		Proportion of SET base who are black	49%	52%
		Proportion of SET base who are female	35%	33%
	Total monetary value of HCD investment	% PG into HCD	15,4%	19,5%

The CSIR is committed to making a contribution to the national efforts to address the skills shortage in science, engineering and technology (SET).

A strong, representative scientific human resources (HR) base is critical for attaining socio-economic growth in South Africa. SET play an integral role in addressing national priorities and responding to societal needs. HCD is listed as a strategic element to drive the knowledge economy in the DST's 10-Year Innovation Plan.

The main priorities in building and transforming human capital include:

- Contributing to national HR development through strategic relationships with tertiary education institutions (TEIs) and HCD programmes
- Growing and transforming the SET base and ensuring recruitment and optimal retention of staff
- Providing opportunities for the professional growth of staff.

The 2007/08 financial year has seen the CSIR HCD strategy embedded in the organisation's research and innovation activities. The targeted amount of 15,4% of the Parliamentary Grant (PG) earmarked for investment to fund HCD was exceeded by 4,1%.

Programmes aimed at achieving HCD include:

- A bursary programme designed to establish a pool of BSc and Honours students in areas with shortages to ensure a supply for the CSIR over the longer term
- A studentship programme for selected students undertaking their Master's and PhD studies to establish a pool of appropriately-qualified researchers in priority areas
- An internship programme offering experiential learning that allows qualified individuals to gain practical experience and acquire core technical skills
- A postdoctoral programme aimed at contributing to the deepening of the SET base and expanding the pool of mentors while strengthening local and international networks

- A research professional development programme with a transformation focus to strengthen research capacity and increase the number of previously disadvantaged individuals at the higher end of career ladders
- Sabbaticals and exchange programmes offering opportunities for selected principal and chief researchers to gain advanced research skills in critical disciplines
- Management and leadership development aimed at equipping managers with competencies needed for greatness in SET leadership.

A school-level intervention will commence in the new financial year to afford learners from deprived social backgrounds opportunities to improve their matriculation results in maths and science to access university education in SET.

CSIR employee breakdown

The total number of employees as at 31 March 2008 was 2 260. The 2006/07 total was 2 248.

The number of full-time postgraduate students supported by the CSIR exceeded the original target of 93 for 2007/08 exponentially with an actual achievement of 222. A healthy skills pipeline showed higher numbers of bursars, interns and studentships in the organisation. The organisation supported 24 postdoctoral students during the financial year.

The CSIR's qualification profile also showed an improvement with 678 staff with Master's or PhD degrees compared to 639 in the previous financial year.

The total number of PhDs has grown by 10,9% and the number of Master's by 3,2% compared to 2006/07. Black staff with PhDs increased from 33,3% in 2006/7 to 34,2% in 2007/08. Black staff with Master's degrees increased from 35,3% in 2006/07 to 41,6% in 2007/08.

The following table shows a comparative view over three years.

Staff category	2005/06	2006/07	2007/08	Projected: 2008/09
Total staff	2 088	2 248	2 260	2 310
SET base	*	1 490	1 512	1 588
Number of staff with Master's and PhDs	551	639	678	692
% of staff in SET base	*	66%	67%	70%
% of black staff in SET base	*	49%	52%	53%
% of females in SET base	*	32%	33%	32%

* SET base data unavailable at 2005/06. Only captured in current form from 2006/07.

Strengthening the SET base and performing relevant R&D

Priority area		Main and supporting KPIs	2007/08 Target	2007/08 Actual
R&D	S&T resource allocation	Review of deployment of Parliamentary Grant (PG)	Research Advisory Panels (RAPs) completed portfolio review of investment in all units	RAPs deployed by all units and centres
	S&T outputs	Publication equivalents	259	343
		New invention disclosures	27	35
Strategic research alliances	Activity of research relationships	Number of collaborative research activities with a value exceeding R1 million	55	65
Contract R&D	Quality of contract R&D	Value of R&D formally recognised as supporting national strategies	R273,5 m	R373,5 m
	Value of contract R&D	Growth of contract R&D income	R667,0 m	R766,0 m

This CSIR imperative encourages the continual renewal of the SET base and involvement in emerging SET areas. It further creates a focus in the research portfolio in line with the organisational research priorities and national imperatives. Inculcated in this objective is the need to develop a portfolio that allows the CSIR to generate impact in the first and second economies, improve the quality of life of South Africans, produce SET outputs that demonstrate world-class technological leadership and innovation and establish partnerships to leverage technologies and competencies developed using the core PG.

Strengthened research alliances and collaborations remain important, as do improved processes for the allocation and investment of the PG.

The capacity to create new basic knowledge improved significantly, as reflected in a marked increase in research outputs, i.e. publications in peer-reviewed literature, increased from 220 in 2006/07 to 343 in 2007/08. Thirty-five new invention disclosures were achieved against a target of 27.

Research alliances

A strong network of research alliances is in place. These include TEIs, other players in the NSI and international organisations. These relationships are key to strengthening the NSI, HCD, and supporting financial sustainability.

The number of collaborative research activities with a value exceeding R1 million that have been performed with TEIs, the private sector and other research organisations exceeded the target of 55 by 10, to achieve an actual of 65 during 2007/08.

Locally, alliances exist with the universities of Pretoria, Cape Town, KwaZulu-Natal, the Witwatersrand, the Western Cape, as well as Stellenbosch University, Walter Sisulu University, the Tshwane University of Technology, and partners such as the Medical Research Council, Eskom and Sasol.

Collaboration with TEIs has resulted in joint projects, peer-reviewed papers as well as the appointment of CSIR staff as student supervisors and examiners.

International alliances include those with the Delft University, Georgia Tech, the universities of Kansas, Cambridge and Zimbabwe, the Fraunhofer Institute, Airbus, Boeing Phantom Works, TNO, and the National Institute for Medical Research in Tanzania.

Areas of collaboration extend across a wide variety of SET fields, including:

- Biofuels
- Bioprospecting
- Climate change
- Coastal engineering
- Drug development
- Earthquake and mine seismology
- Environment and coastal zone management
- Explosive event and human effects research
- Food science and technology
- Food security
- Forestry
- Human resource development
- Information and communications technology
- Lasers
- Material sciences
- Mechatronics and robotics
- Pavement engineering
- Polymer nanocomposites
- Renewable energy
- Rural infrastructure
- Sensors science
- Sustainability science
- Sustainable rural development
- Textiles
- The built environment
- Validation of traditional medicines through reverse pharmacology
- Water resource management.

A strong focus has been to strengthen international relationships with member organisations of the Global Research Alliance, Regional Research Alliance and the World Association of Industrial and Technological Research Organizations. In that regard, particular attention has been given to initiating more activities with the Danish Technology Institute, VTT (Finland), the Standard and Industrial Research Institute of Malaysia and the Commonwealth Scientific and Industrial Organisation in Australia in areas such as natural resources, forestry and forest products, bioscience, nanotechnology, materials and advanced manufacturing.

The Swiss/South Africa Collaborative Research Programme, which is managed by the CSIR, supports projects in the fields of biotechnology and nanotechnology, human and social sciences, and public health and biomedicine.

Contract R&D

The target set overall for income from contract R&D was exceeded by R99,0 million to achieve R766,0 million for 2007/08. This includes R59,1 million (2006/07: R nil) ring-fenced funding from the Department of Science and Technology.

More than 60% of contract work is aligned with national strategies. The value of CSIR R&D work formally recognised as supporting national strategies increased by nearly R100 million – from R274,34 million in 2006/07 to R373,5 million in 2007/08.

The CSIR supports 25 key national strategies and programmes. These include the National Crime Prevention Strategy, the Joint Initiative on Priority Skills Acquisition, the National Biotechnology Strategy, the National Biodiversity Strategy, the National Climate Change Response Strategy for South Africa, the Hydrogen Economy and Energy R&D Strategy, the National Water Resources Strategy, the National Spatial Development Perspective, the National Transport Master Plan, the Comprehensive Housing Plan, the Advanced Manufacturing Technology Strategy, the Nanotechnology Science and Technology Frontier Programme, the National Space Strategy, the National Information and Communications Technology R&D Strategy, and the Industrial Policy Action Plan.

Transferring technology and skilled human capital

Priority area		Main and supporting KPIs	2007/08 Target	2007/08 Actual
R&D outcomes	A robust and attractive portfolio of intellectual property (IP) and technologies	Number of new technology packages available for transfer	23	39
	An increased rate of technology transfer for both commercial gain and social good	Royalty and licence revenue	R8,4 m	R9,1 m

The CSIR encourages the development of new technology demonstrators and new areas of investment that have high potential impact. This ensures a strong IP portfolio with opportunities for technology transfer and more successful licensing and royalty income earnings.

The organisation further contributes to industry development through knowledge and technology transfer that impacts on and leads to the development of companies, industrial sectors and significant private sector investments. It also implements multi-year contract R&D initiatives, which strengthen the NSI and grow contract R&D with the private sector.

Social impact considerations are built more strongly into the selection and evaluation criteria of investment decisions. The CSIR's contribution to the second economy is being improved continually by increasing the capacity of the CSIR's office dedicated to delivering technology solutions that contribute to poverty alleviation. One of the highlights during 2007/08 was the implementation of 26 essential oils and medicinal plants projects located in underdeveloped areas of the country that provide employment to more than 350 people.

Another highlight during 2007/08 was the formalisation of a new IP and technology transfer strategy, and the number of new technology packages available for transfer, which saw the target of 23 exceeded by 16 to achieve 39.

Royalty and licence revenue from technology transfer for commercial gain and social good amounted to R9,1 million.

CSIR portfolio performance	Achieved
Invention disclosures	35
Technology packages available for transfer	39
Royalty income	R9,1 m

Financial sustainability and good corporate governance

Priority area		Main and supporting KPIs	2007/08 Target	2007/08 Actual
Financial sustainability	Operational sustainability	Margin from operating activities before provision for performance bonus and investment income	R15,6 m	R43,4 m
Corporate governance and responsibility	Corporate governance	Number of significant findings on external audit report	None	None
	Quality and operational excellence	Implementation of open source software as the basis of CSIR computing	75%	10,7%
Corporate citizenship		B-BBEE rating	Level 4 contributor	Subsequent to year end, and following an external audit, a rating of Level 3 has been awarded to the CSIR
		Energy consumption	Achieve 1,2% reduction in energy consumption on previous year	The energy efficiency programme achieved on average 1,1% reduction in energy consumption year-on-year

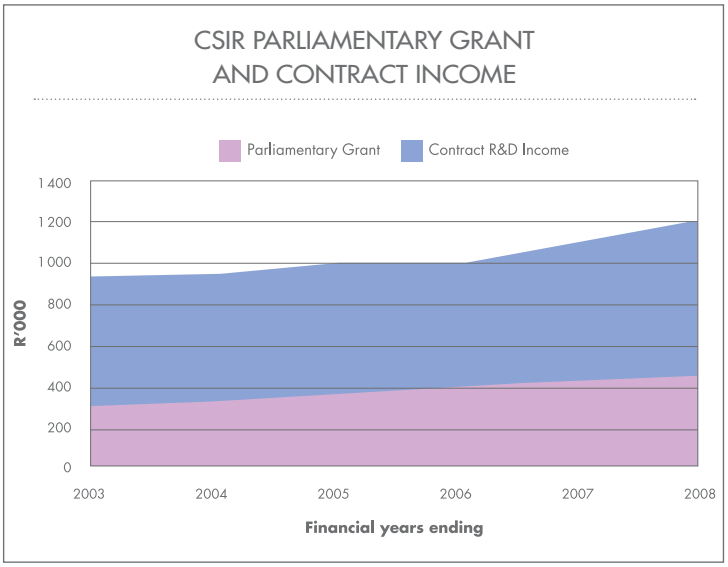
Financial performance overview

Income

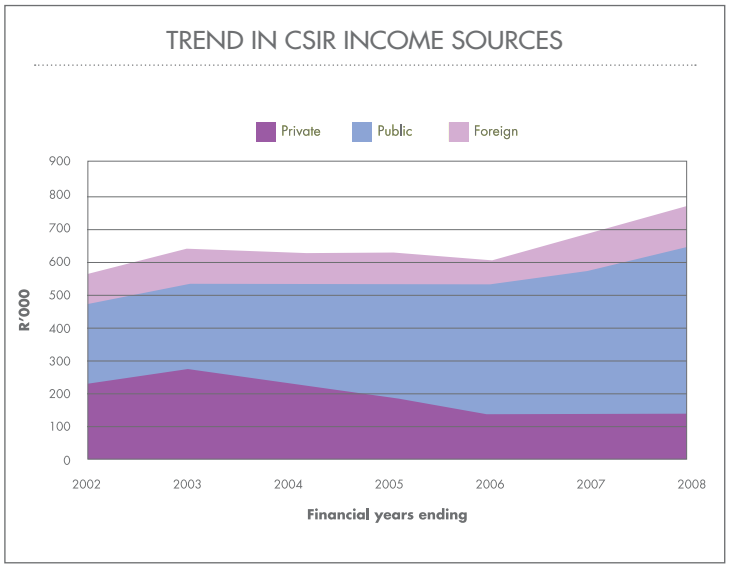
The Parliamentary Grant allocated to the CSIR increased by 5% to R445 million from the prior year amount of R423,8 million.

The total contract income grew by 19% to R766 million (2006/07: R643,6 million). This includes R59,1 million (2006/07: R nil) ring-fenced funding from the DST.

The total operating income of the CSIR increased by 8,6% to an amount of R1 217,9 million. (2006/07: R1 121,4 million).



Executive Report



The CSIR's alignment with national strategic priorities resulted in the public sector contract income increasing by R105,8 million to R508,8 million. International sector contract income increased by 12,8% to R119,6 million and private sector contract income of R137,7 million showed a marginal increase compared to the prior financial year.

The CSIR Group operating revenue increased by R84,7 million to an amount of R1 236,3 million (2006/07: R1 151,6 million), an increase of 7,4%.

FIVE-YEAR REVIEW OF INCOME AND EXPENSE INDICATORS

	2008 R'000	2007 R'000	2006 R'000	2005 R'000	2004 R'000
Total income	1 271 062	1 150 467	1 016 104	1 029 932	964 718
Parliamentary Grant recognised as income	429 013	428 055	391 077	356 992	321 996
Contract income, royalty, other income and net finance income	842 049	722 412	625 027	672 940	642 722
Private sector	137 683	134 647	146 765	187 592	231 751
Public sector	508 779	435 391	370 892	345 472	311 265
International sector (incl. Africa)	119 584	106 027	82 254	94 291	80 530
Royalties and other income	22 908	17 321	3 412	7 369	4 168
Net finance income	53 095	29 026	21 704	38 216	15 008
Operating expenditure	1 219 665	1 125 588	1 047 745	987 348	948 481
Employee remuneration	619 529	579 035	624 202	557 593	527 722
Operating expenses	572 454	496 752	384 157	388 592	384 691
Depreciation	27 682	49 801	39 386	41 163	36 068

Net profit and cash flow

The net profit of the CSIR is R51,7 million (2006/07: R21,6 million). The CSIR experienced growth in net investment income, excluding fair value adjustments, which contributed to the net profit. Net profit for the CSIR Group is R54,2 million (2006/07: R26,5 million)

Cash flow generated from operating activities for the year being reported on was R167,3 million (2006/07: R341,3 million). Cash flow from investing activities amounted to R152,5 million and included the transfer of the CSIR National Metrology Laboratory (NML) cash reserves of R9,8 million to the newly established entity. The cash and cash equivalent holdings increased to R673,3 million (2006/07: R557,5 million, including long-term fixed deposits).

FIVE-YEAR RATIO ANALYSIS

	2008 R'000	2007 R'000	2006 R'000	2005 R'000	2004 R'000
Operating expenses					
Remuneration as a % of total income (excl. finance income)	50.9%	51.6%	62.8%	56.2%	55.6%
Remuneration as a % of total expenditure	50.8%	51.2%	59.6%	56.5%	55.6%
Asset management					
Net asset turn	3.2	3.2	2.9	2.7	2.8
Current ratio	1.2	0.9	1.0	1.2	1.2
Cash flow					
Net cash from operating activities	167 307	341 357	146 659	131 909	110 937
Cash and cash equivalents end of year (including long-term fixed deposits)	673 309	557 529	289 070	295 417	208 737

Definitions

Net asset turn – Total revenue (incl. investment income) divided by net assets

Current ratio – Current assets divided by current liabilities

The post-retirement medical benefit expense and liability, distribution from the National Laser Centre Trust (2004) and the effects of the adoption of SA GAAP, AC133: Financial instruments – recognition and measurement have been excluded for the comparison of financial indicators.

Energy saving

The CSIR's performance on energy saving for the 2007/08 financial year has been acceptable considering an increase in energy demand due to organisational development and re-engineering. The organisation's energy efficiency performance for 2007/08 showed a 1,1% reduction in energy consumption. This is despite the fact that the maximum demand increased from 6,5 MVA to 7,2 MVA due to, among others, an increase in internal capacity requirements resulting from the establishment or expansion of new research areas.

Migration to open source software

The implementation of open source software (OSS) as the basis of CSIR computing has seen 11% of the organisation's staff migrating to OSS during the past financial year. A culture of training in terms of optimal use of OSS has been entrenched and the CSIR has established a research group focused on developing a Linux desktop dedicated to scientific computing to support affordable and flexible scientific infrastructure in Africa and further afield. Internships and studentships were initiated to support the advancement of human capital in advanced software development. The Department of Science and Technology and the State Information and Technology Agency continue to be our main partners in this regard.

Broad-based Black Economic Empowerment audit

In line with the Black Empowerment Act, Act 53 of 2003, and the dti Codes of Good Practice published in February 2007, the CSIR has undergone an audit and verification of its B-BBEE performance and status. The audit involved assessment of the organisation's performance in the following six areas: Management control, employment equity, skills development, preferential procurement, enterprise development and socio-economic development. The audit was carried out by BEESA and Moloto Solutions subsequent to year end, and placed the CSIR at a Level 3.

Income Statements

for the year ended 31 March 2008

	Notes	GROUP 2008 R'000	GROUP 2007 R'000	CSIR 2008 R'000	CSIR 2007 R'000
Revenue	2	**1 222 379**	1 143 185	**1 204 129**	1 114 928
Other income		**13 943**	8 448	**13 838**	6 513
Total operating income		**1 236 322**	1 151 633	**1 217 967**	1 121 441
Expenditure					
Employees' remuneration		**628 319**	592 828	**619 432**	582 676
Depreciation and amortisation	6 & 7	**28 061**	50 682	**27 682**	49 801
Operating expenses		**580 593**	510 700	**572 454**	496 752
Total operating expenditure		**1 236 973**	1 154 210	**1 219 568**	1 129 229
Finance income	4	**61 271**	36 588	**59 755**	35 717
Finance expense	4	**(6 421)**	(6 376)	**(6 414)**	(6 285)
Share of loss of joint ventures and associates		**(58)**	(999)	**–**	–
Operating profit for the year before taxation		**54 141**	26 636	**51 740**	21 644
Income tax expense	5	**135**	(103)	**–**	–
Profit for the year		**54 276**	26 533	**51 740**	21 644
Attributable to:					
Stakeholders		**54 276**	26 533	**51 740**	21 644
Profit for the year		**54 276**	26 533	**51 740**	21 644

Balance Sheets

31 March 2008

	Notes	GROUP 2008 R'000	GROUP 2007 R'000	CSIR 2008 R'000	CSIR 2007 R'000
ASSETS					
Non-current assets		**225 429**	419 135	**241 393**	436 601
Property, plant and equipment	6	**225 429**	218 855	**225 118**	218 485
Intangible assets	7	**–**	280	**–**	–
Interest in joint ventures and associates	8	**–**	–	**1**	1
Interest in subsidiaries	9			**16 274**	18 115
Other investments	10	**–**	200 000	**–**	200 000
Current assets		**1 115 154**	664 422	**1 091 583**	637 408
Trade and other receivables	11	**267 076**	146 906	**261 672**	141 606
Inventory and contracts in progress	12	**61 712**	43 203	**61 712**	43 203
Cash and cash equivalents	25	**691 476**	379 243	**673 309**	357 529
Non-current asset held for sale	6.1	**94 890**	95 070	**94 890**	95 070
TOTAL ASSETS		**1 340 583**	1 083 557	**1 332 976**	1 074 009
EQUITY AND LIABILITIES					
Reserves		**392 732**	347 716	**387 023**	344 545
Retained earnings		**379 737**	334 723	**376 273**	333 795
Self-insurance reserve		**10 750**	10 750	**10 750**	10 750
Non-distributable reserve:					
Foreign currency translation reserve		**2 245**	2 243		
Non-current liabilities		**8 595**	12 764	**8 595**	12 751
Post-retirement medical benefits	18.4	**8 595**	12 751	**8 595**	12 751
Deferred tax liabilities	13	**–**	13	**–**	–
Current liabilities		**939 256**	723 077	**937 358**	716 713
Advances received	14	**448 854**	356 576	**448 854**	356 576
Trade and other payables	15	**413 807**	294 253	**411 909**	287 889
Provisions	16	**76 595**	72 248	**76 595**	72 248
TOTAL EQUITY AND LIABILITIES		**1 340 583**	1 083 557	**1 332 976**	1 074 009

Statements of Changes in Equity

for the year ended 31 March 2008

	Retained earnings R'000	Self-insurance reserve* R'000	Non-distributable reserve** R'000	Total R'000
GROUP				
Balance at 31 March 2006	308 190	10 750	989	**319 929**
Profit for the year	26 533	–	–	**26 533**
Exchange differences arising from translations of foreign operations	–	–	1 254	**1 254**
Balance at 31 March 2007	**334 723**	**10 750**	**2 243**	**347 716**
Transfer of the National Metrology Laboratory (NML) ***	(9 262)	–	–	**(9 262)**
Profit for the year	54 276	–	–	**54 276**
Exchange differences arising from translations of foreign operations	–	–	2	**2**
Balance at 31 March 2008	**379 737**	**10 750**	**2 245**	**392 732**
CSIR				
Balance at 31 March 2006	312 151	10 750	–	**322 901**
Profit for the year	21 644	–	–	**21 644**
Balance at 31 March 2007	**333 795**	**10 750**	**–**	**344 545**
Transfer of the National Metrology Laboratory (NML) ***	(9 262)	–	–	**(9 262)**
Profit for the year	51 740	–	–	**51 740**
Balance at 31 March 2008	**376 273**	**10 750**	**–**	**387 023**

* Refer to note 20

** The non-distributable reserve consists of a foreign currency translation reserve. The foreign currency translation reserve comprises all foreign currency differences arising from the translation of the financial statements of foreign operations as well as from the translation of liabilities that hedge the Group's net investment in a foreign subsidiary, if applicable

*** Refer to note 27

Cash Flow Statements

for the year ended 31 March 2008

	Notes	GROUP 2008 R'000	GROUP 2007 R'000	CSIR 2008 R'000	CSIR 2007 R'000
Cash flow from operating activities					
Cash receipts from external customers		**806 554**	745 861	**788 200**	717 593
Parliamentary Grant received		**445 046**	423 854	**445 046**	423 854
Cash paid to suppliers and employees		**(1 137 127)**	(843 914)	**(1 119 034)**	(829 116)
Cash generated by operations	24	**114 473**	325 801	**114 212**	312 331
Net finance income	4	**54 604**	29 806	**53 095**	29 026
Income taxes paid		**122**	(109)	**–**	–
Net cash from operating activities		**169 199**	355 498	**167 307**	341 357
Cash flow from investing activities					
Acquisition of property, plant and equipment		**(41 175)**	(65 984)	**(41 083)**	(65 803)
Proceeds on disposal of property, plant and equipment		**55**	427	**55**	127
Decrease/(increase) in subsidiary loans		**–**	–	**4 846**	(1 801)
Proceeds on liquidation and deregistration of subsidiaries	28	**154**	(4)	**–**	–
Transfer of the National Metrology Laboratory (NML)	27	**(9 813)**	–	**(9 813)**	–
Increase in interest in joint ventures and associates		**(1 473)**	(913)	**(1 473)**	(914)
Decrease/(increase) in investments		**200 000**	(200 000)	**200 000**	(200 000)
Acquisition of intangible assets		**(619)**	(459)	**–**	–
Net cash used in investing activities		**147 129**	(266 933)	**152 532**	(268 391)
Cash flow from financing activities					
Decrease in long-term liabilities		**(4 059)**	(4 507)	**(4 059)**	(4 507)
Net cash used in financing activities		**(4 059)**	(4 507)	**(4 059)**	(4 507)
Net increase in cash and cash equivalents		**312 269**	84 058	**315 780**	68 459
Cash and cash equivalents at beginning of the year		**379 243**	294 011	**357 529**	289 070
Effect of foreign exchange rate changes		**(36)**	1 174	**–**	–
Cash and cash equivalents at end of the year	25	**691 476**	379 243	**673 309**	357 529

1 PRINCIPAL ACCOUNTING POLICIES

The CSIR is a parastatal (enacted by The Scientific Research Council Act, Act 46 of 1988) domiciled in the Republic of South Africa. The address of the CSIR's principal place of business is Meiring Naudé Road, Brummeria, Pretoria.

The consolidated Annual Financial Statements are prepared on the historical cost basis except for financial instruments held for trading and financial instruments classified as available-for-sale, which are stated at fair value. The consolidated Annual Financial Statements have been prepared in accordance with statements of South African Generally Accepted Accounting Practice (SA GAAP) and the Public Finance Management Act, Act 1 of 1999 as amended by Act 29 of 1999. The following principal accounting policies have been consistently applied by group entities in all material respects.

The preparation of financial statements requires management to make judgements, estimates and assumptions that affect the application of policies and reported amounts of assets and liabilities, income and expenses. The estimates and associated assumptions are based on historical experience and various other factors that are believed to be reasonable under the circumstances, the result of which forms the basis of making judgements about carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates.

Estimates and underlying assumptions are reviewed on an ongoing basis. Revisions to accounting estimates are recognised in the period in which the estimate is revised and in any future periods affected.

The consolidated Annual Financial Statements are presented in South African rand (R), which is the CSIR's functional currency, and are rounded off to the nearest thousand.

Basis of consolidation

Interest in subsidiaries

The consolidated Annual Financial Statements incorporate the Annual Financial Statements of the CSIR and the Annual Financial Statements of the entities under its control from the date that control commences until the date that control ceases. Control exists when the CSIR has the power to govern the financial and operating policies of an investee entity so as to obtain benefits from its activities. In assessing control, potential voting rights that are presently exercisable are taken into account.

On acquisition, the assets and liabilities of the relevant subsidiaries are measured at their fair values at the date of acquisition. The interest of minority shareholders is stated at the minority's proportion of the fair values of the assets and liabilities recognised. The operating results of subsidiaries acquired or disposed of during the reporting period are included in the consolidated income statement from the effective date of acquisition or up to the effective date of disposal. All significant intercompany balances between group entities have been eliminated on consolidation.

Where a group enterprise transacts with a subsidiary company, unrealised gains and losses are eliminated in preparing the consolidated financial statements.

Any excess of net assets of a subsidiary over the cost of an acquisition is treated in terms of the Group's accounting policy on goodwill.

Interest in associates

An associate is an entity over which the Group is in a position to exercise significant influence, but not control, through participation in the financial and operating policy decisions of the investee. The Group share of the total recognised gains and losses of associates is incorporated in the consolidated financial statements, from the date that significant influence commences until the date that significant influence ceases, using the equity method of accounting. The carrying amount of such interests is reduced to recognise any impairment, other than a temporary impairment, in the value of individual investments.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Interest in associates (continued)

Where a group enterprise transacts with an associate company, unrealised gains and losses are eliminated to the extent of the group's interest in the relevant associate company, except where unrealised losses provide evidence of an impairment of the asset transferred. When the Group's share of losses exceeds its interest in an investee, the carrying amount of that interest (including any long-term investments) is reduced to nil and the recognition of further losses is discontinued except to the extent that the Group has an obligation or has made payments on behalf of the investee.

Any excess of net assets of an associate over the cost of an acquisition is treated in terms of the Group's accounting policy on goodwill.

Interest in joint ventures

A joint venture is a contractual arrangement whereby the CSIR and other parties undertake economic activity, which is subject to joint control.

Interests in jointly-controlled entities are accounted for by means of the equity method from the date that joint control commences until the date that joint control ceases. The carrying amount of such interests is reduced to recognise any impairment, other than a temporary impairment, in the value of individual investments.

Where a group enterprise transacts with a joint venture, unrealised gains and losses are eliminated to the extent of the group's interest in the relevant joint venture, except where unrealised losses provide evidence of an impairment of the asset transferred.

Any excess of net assets of a joint venture over the cost of an acquisition is treated in terms of the Group's accounting policy on goodwill.

Foreign currencies

Foreign operations

All foreign subsidiaries of the CSIR are foreign operations.

The financial statements of foreign subsidiaries are translated into South African rand as follows:

- Assets and liabilities, including goodwill and fair value adjustments on consolidation, at rates of exchange ruling at the reporting entities' financial year end
- Revenue, expenditure and cash flow items at the average rates of exchange during the relevant financial year (the average rates approximate fair value).

Differences arising on translation are reflected as non-distributable reserves called a foreign currency translation reserve (FCTR). When a foreign operation is disposed of, in part or in full, the relevant amount in the FCTR is transferred to profit or loss.

Foreign exchange gains and losses arising from a monetary item receivable from or payable to a foreign operation, the settlement of which is neither planned nor likely in the foreseeable future, are considered to form part of a net investment in a foreign operation and are recognised directly in equity in the FCTR.

Foreign currency transactions and balances

Transactions in foreign currencies are converted to South African rand at the rate of exchange ruling at the date of the transactions. Monetary assets and liabilities denominated in foreign currencies are stated in South African rand using the rates of exchange ruling on the balance sheet date. The resulting exchange differences are dealt with in the income statement. Non-monetary assets and liabilities stated at fair value are translated at foreign exchange rates ruling at the date the fair value was determined.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Property, plant and equipment

Owned assets

Land is stated at cost less accumulated impairment losses. Buildings, plant, equipment and vehicles are stated at cost less accumulated depreciation and accumulated impairment losses.

The cost of self-constructed assets includes the cost of materials, direct labour, the initial estimate, where relevant, of the costs of dismantling and removing the items and restoring the site on which these are located and an appropriate proportion of production overheads.

Where parts of an item of property, plant and equipment have different useful lives, these are accounted for as separate items (major components) of property, plant and equipment.

Gains and losses on disposal of an item of property, plant and equipment are determined by comparing proceeds from disposal with the carrying amount of property, plant and equipment and are recognised in profit or loss.

Leased assets

Assets acquired by way of finance lease are stated at an amount equal to the lower of the fair value and the present value of the minimum lease payments at inception of the lease, less accumulated depreciation and impairment losses. Assets held under finance leases are depreciated over the expected useful lives of these on the same basis as owned assets or, where shorter, the term of the relevant lease.

Subsequent costs

The Group recognises in the carrying amount of an item of property, plant and equipment, the cost of replacing a part of such an item when that cost is incurred, if it is probable that the future economic benefits embodied in the item will flow to the Group and the cost of the item can be measured reliably. The carrying amount of the replaced part is derecognised. The costs of the day-to-day servicing of property, plant and equipment are recognised in profit or loss as incurred.

Depreciation

Depreciation is based on cost less residual value and is calculated on the straight-line method from the day the assets are available for use, at rates considered appropriate to write off carrying values over the estimated useful lives of the assets, except for:

- Assets specifically acquired for a contract, which are depreciated over the life of the contract
- Strategic assets of limited commercial application, which are written down to expected residual value at acquisition, with the remaining carrying value depreciated over the estimated useful lives of the assets.

The estimated lives of the main categories of property, plant and equipment are as follows:

- Buildings : 40 years
- Plant : 10 years
- Equipment : 3 to 10 years
- Vehicles : 10 years

Depreciation methods, useful lives and current residual values, if not insignificant, are reassessed annually.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Intangible assets

Research and development

Expenditure on research activities, undertaken with the prospect of gaining new scientific or technical knowledge and understanding, is recognised in profit or loss when incurred.

Development activities involve a plan or design for the production of new or substantially-improved products and processes. Development expenditure is capitalised only if development costs can be measured reliably, the product or process is technically and commercially feasible, future economic benefits are probable, and the Group intends to and has sufficient resources to complete development and to use or sell the asset. The expenditure capitalised includes the cost of materials, direct labour and overhead costs that are directly attributable to preparing the asset for its intended use. Other development expenditure is recognised in profit or loss when incurred.

Capitalised development expenditure is measured at cost less accumulated amortisation and accumulated impairment losses.

Investment in technology

Investment in technology licensing projects and dividend producing rights is capitalised at cost and is stated at cost less accumulated amortisation and accumulated impairment losses. Investment in technology is amortised over the expected useful life.

Development expenditure and intellectual property

Development expenditure and intellectual property consist of capitalised development costs as approved by the Board. Capitalisation is limited to the present value of expected net future income (refer to research and development).

Goodwill

Goodwill arising on consolidation represents the excess of the cost of an acquisition over the fair value of the Group's interest of the net assets of the acquired subsidiary, associate or joint venture at the date of the acquisition (refer to basis of consolidation, interest in associates and interest in joint ventures). All business combinations are accounted for by applying the purchase method.

Goodwill arising from the acquisition of a joint venture or an associated company is included within the carrying amount of the joint venture or associated company. Goodwill arising from a subsidiary is presented separately in the balance sheet and tested annually for impairment and is stated at cost less accumulated impairment losses. Goodwill is allocated to cash-generating units. On disposal of a subsidiary, joint venture or associated company, the attributable amount of goodwill is included in the determination of the profit or loss on disposal.

When an excess arising on an acquisition is negative (negative goodwill), it is recognised directly in profit or loss.

Subsequent costs

Subsequent expenditure on capitalised intangible assets is capitalised only when it increases the future economic benefits embodied in the specific asset to which it relates. All other expenditure, including expenditure on internally generated goodwill and brands, is expensed as incurred.

Amortisation

Amortisation is based on cost and calculated on the straight-line method at rates considered appropriate to write off carrying values over the estimated useful lives of the intangible assets with definite useful lives. Intangible assets are amortised from the day they are available for use.

The estimated lives of intangible assets with definite useful lives are as follows:

- Investment in technology : 3 to 10 years
- Development expenditure and intellectual property : 1 to 3 years

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Impairment

Financial assets

A financial asset is assessed at each reporting date to determine whether there is any objective evidence that it is impaired. A financial asset is considered to be impaired if objective evidence indicates that one or more events have had a negative effect on the estimated future cash flows of that asset.

An impairment loss in respect of a financial asset measured at amortised cost is calculated as the difference between its carrying amount, and the present value of the estimated future cash flows discounted at the original effective interest rate. An impairment loss in respect of an available-for-sale financial asset is calculated by reference to its current fair value.

Individually-significant financial assets are tested for impairment on an individual basis. The remaining financial assets are assessed collectively in groups that share similar credit risk characteristics.

All impairment losses are recognised in profit or loss. Any cumulative loss in respect of an available-for-sale financial asset recognised previously in equity is transferred to profit or loss.

An impairment loss is reversed if the reversal can be related objectively to an event occurring after the impairment loss was recognised. For financial assets measured at amortised cost and available-for-sale financial assets that are debt securities, the reversal is recognised in profit or loss. For available-for-sale financial assets that are equity securities, the reversal is recognised directly in equity.

Non-financial assets

The carrying amounts of the Group's non-financial assets, other than biological assets, investment property, inventories and deferred tax assets, are reviewed at each reporting date to determine whether there is any indication of impairment. If any such indication exists then the asset's recoverable amount is estimated. For goodwill and intangible assets that have indefinite lives or that are not yet available for use, the recoverable amount is estimated at each reporting date.

An impairment loss is recognised if the carrying amount of an asset or its cash-generating unit exceeds its recoverable amount. A cash-generating unit is the smallest identifiable asset group that generates cash flows that are largely independent from other assets and groups. Impairment losses are recognised in profit or loss. Impairment losses recognised in respect of cash-generating units are allocated first to reduce the carrying amount of any goodwill allocated to the units and then to reduce the carrying amount of the other assets in the unit (group of units) on a *pro rata* basis.

The recoverable amount of an asset or cash-generating unit is the greater of its value in use and its fair value less costs to sell. In assessing value in use, the estimated future cash flows are discounted to their present value using a pre-tax discount rate that reflects current market assessments of the time value of money and the risks specific to the asset.

An impairment loss in respect of goodwill is not reversed. In respect of other assets, impairment losses recognised in prior periods are assessed at each reporting date for any indications that the loss has decreased or no longer exists. An impairment loss is reversed if there has been a change in the estimates used to determine the recoverable amount. An impairment loss is reversed only to the extent that the asset's carrying amount does not exceed the carrying amount that would have been determined, net of depreciation or amortisation, if no impairment loss had been recognised.

Non-current assets held for sale

Non-current assets (or disposal groups comprising assets and liabilities) that are expected to be recovered primarily through sale rather than through continuing use, are classified as held for sale. Immediately before classification as held for sale, the assets (or components of a disposal group) are remeasured in accordance with the Group's accounting policies. Thereafter, the assets (or disposal group) are generally measured at the lower of their carrying amount and fair value less cost to sell. Impairment losses on initial classification as held for sale and subsequent gains or losses on remeasurement are recognised in profit or loss. Gains are not recognised in excess of any cumulative impairment loss.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Retirement benefits

Pension fund

The Group operates a defined contribution plan, the assets of which are held in a separate trustee-administered fund. The benefits payable by the fund in the future, due to retirements and withdrawals from the fund, are contributions to the fund together with fund interest at a rate determined by the valuator with the consent of the trustees. The rate is so determined that the value of the total of the fund shall not exceed the value of the total assets of the fund. The Group's contribution to the plan is charged to the income statement when incurred.

Post-retirement benefits other than pensions

The Group provides post-retirement medical benefits to qualifying employees, which is deemed to be a defined benefit plan. The expected costs of these benefits are determined using the projected unit credit method, with actuarial valuations being carried out at each balance sheet date. Contributions are made to the relevant funds over the expected service lives of the employees entitled to those funds. The estimated cost of providing such benefits is charged to the income statement on a systematic basis over the employees' working lives within the Group.

Actuarial gains and losses are recognised in full in the income statement in the year when actuarially determined. The amount recognised in the balance sheet represents the present value of the post-retirement medical aid contribution reduced by the fair value of the plan assets. Any asset resulting from this calculation is limited to actuarial losses and the present value of available refunds and reductions in future contributions to the plan.

Inventory and contracts in progress

Raw materials and finished goods are stated at the lower of cost and net realisable value. Cost of inventory is determined by the weighted average method. Net realisable value represents the estimated selling price less all estimated costs to completion and costs to be incurred in selling.

Contracts in progress are stated as a percentage of the sales value of work completed, after provision for losses relating to the stage of completion and any foreseeable losses to completion of the contract.

Taxation

Income tax expense comprised current and deferred tax. The charge for taxation is based on the profit or loss for the year as adjusted for items that are non-taxable or disallowed. It is calculated using tax rates that have been enacted or substantially enacted at the balance sheet date. Income tax expense is recognised in profit or loss except to the extent that it relates to items recognised directly in equity, in which case it is recognised in equity.

Deferred tax is accounted for using the balance sheet method in respect of temporary differences arising from differences between the carrying amounts of assets and liabilities in the financial statements and the corresponding tax basis used in the computation of the taxable profit.

Where the tax effects of temporary differences, including those arising from tax losses, give rise to a deferred tax asset, the asset is recognised only if it is probable that future taxable profits will be sufficient to allow the tax benefit of the loss to be realised. Deferred tax assets are reviewed at each reporting date and are reduced to the extent that it is no longer probable that the related tax benefit will be realised.

Deferred tax assets and liabilities are offset when these relate to income taxes levied by the same taxation authority and the Group intends to settle its current tax assets and liabilities on a net basis.

The amount of deferred tax provided is based on the expected manner of realisation or settlement of the carrying amount of assets and liabilities using tax rates enacted or substantively enacted at the balance sheet date. Deferred tax is charged to the income statement except to the extent that it relates to a transaction that is recognised directly in equity. The effect on deferred tax of any changes in tax rates is recognised in the income statement except to the extent that it relates to items previously charged or credited directly to equity.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Provisions

Provisions are recognised when the Group has a present legal or constructive obligation as a result of past events, for which it is probable that an outflow of economic benefits will be required to settle the obligation, and a reliable estimate can be made of the amount of the obligation. Provisions are determined by discounting the expected future cash flows at a pre-tax rate that reflects current market assessments of the time value of money and the risks specific to the liability.

A provision for onerous contracts is recognised when the expected benefits to be derived by the Group from a contract are lower than the unavoidable cost of meeting its obligations under the contract. The provision is measured at the present value of the lower of the expected cost of terminating the contract and the expected net cost of continuing with the contract. Before a provision is established, the Group recognises any impairment loss on the assets associated with that contract.

Government grants

Government grants that compensate the Group for expenses incurred are recognised as income on a systematic basis over periods necessary to match the assistance with the related expenses it is intended to compensate.

Grants that compensate the Group for the cost of an asset are deducted in arriving at the carrying amount of the acquired asset.

Revenue recognition

Revenue from the sale of goods is measured at the fair value of the consideration received or receivable, net of returns and allowances, trade discounts and volume rebates. Revenue is recognised when the significant risks and rewards of ownership have been transferred to the buyer, recovery of the consideration is probable, the associated costs and possible return of goods can be estimated reliably, there is no continuing management involvement with the goods, and the amount of revenue can be measured reliably.

Revenue from services rendered is recognised in profit or loss in proportion to the stage of completion of the transaction at the reporting date. The stage of completion is assessed by reference to work performed as at balance sheet date.

Contract revenue includes the initial amount agreed in the contract plus any variations in contract work, claims and incentive payments to the extent that it is probable that these will result in revenue and can be measured reliably. As soon as the outcome of a contract can be estimated reliably and contract revenue and expenses are recognised in profit or loss in proportion to the stage of completion of the contract.

The stage of completion is assessed by reference to work performed as at balance sheet date. When the outcome of a contract cannot be estimated reliably, contract revenue is recognised only to the extent of contract costs incurred that are likely to be recoverable. An expected loss on a contract is recognised immediately in profit or loss.

The annual Parliamentary Grant is adjusted for the grant received for projects started before year end, but not completed as detailed above (see Government grants).

Royalties are accrued based on the stipulations of the applicable contracts.

Finance income/expense

Finance income comprises interest receivable on funds invested, dividend income, fair value adjustments on investments and interest payable on borrowings. Interest income is recognised in the income statement as it accrues, using the effective interest rate method. Dividend income is recognised in the income statement on the date the entity's right to receive payments is established (which is when the dividend is declared). Interest payable on borrowings is calculated using the effective interest rate method.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Expenses

Operating lease payments

Payments made under operating leases are recognised in the income statement on a straight-line basis over the term of the lease. Lease incentives received are recognised in the income statement as an integral part of the total lease expense.

Finance lease payments

Minimum lease payments are apportioned between the finance charge and the reduction of the outstanding liability. The finance charge is allocated to each period during the lease term so as to produce a constant periodic rate of interest on the remaining balance of the liability.

Financial instruments

Financial instruments are initially measured at fair value plus, for instruments not at fair value through profit or loss, any directly attributable transaction costs, when the Group has become a party to contractual provision of the instrument. Subsequent to initial recognition, these instruments are measured as set out below.

Trade and other receivables

Trade receivables are subsequently measured at amortised cost using the effective interest method less any impairment losses, which approximate the fair value of these due to the short-term nature thereof.

Receivables originated by the Group and not held for trading are measured at amortised cost using the effective interest rate method if these have a fixed maturity.

Investments and loans

Investments, other than in subsidiaries, associates or joint ventures, are recognised at fair value. Dividends are accounted for on the last day of registration in respect of listed investments and when declared in respect of unlisted investments. On disposal of an investment, the difference between the net disposal proceeds and the carrying amount is charged or credited to the income statement.

Loans are measured at amortised cost using the effective interest rate method if these have a fixed maturity, or at cost if there is no fixed maturity.

Cash and cash equivalents

Cash on hand is stated at face value, which is its fair value. Cash and cash equivalents comprise bank balances, cash on deposit and cash on hand.

Forward exchange contracts

Forward exchange contracts are fair valued and gains and losses are recognised in the income statement. Hedge accounting is not applied.

Trade and other payables and advances received

Trade and other payables and advances received are stated at amortised cost, which approximates the fair value of these due to the short-term nature thereof.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

De-recognition

Financial assets (or a portion thereof) are de-recognised when the Group realises the rights to the benefits specified in the contract, the rights expire or the Group surrenders or otherwise loses control and does not retain substantially all risks and rewards of the asset. On de-recognition, the difference between the carrying amount of the financial asset and proceeds receivable is included in the income statement.

Financial liabilities (or a portion thereof) are de-recognised when the obligation specified in the contract is discharged, cancelled or expires. On de-recognition, the difference between the carrying amount of the financial liability and amount paid for it is included in the income statement.

Fair value methods and assumptions

The fair value of financial instruments traded in an organised financial market is measured at the applicable quoted prices necessary to realise the asset or settle the liability.

The fair value of financial instruments not traded in an organised financial market is determined using a variety of valuation methods and assumptions that are based on market conditions and risk existing at balance sheet date, including independent appraisals and discounted cash flow methods.

Related parties

The Group operates in an economic environment currently dominated by entities directly or indirectly owned by the South African government. As a result of the constitutional independence of all three spheres of government in South Africa, only parties within the national sphere of government will be considered to be related parties.

Key management is defined as being individuals with the authority and responsibility for planning, directing and controlling the activities of the entity. All individuals from the level of Group Executive up to the Board of Directors are regarded as key management.

Close family members of key management are considered to be those family members who may be expected to influence, or be influenced by key management individuals or other parties related to the entity.

	GROUP				CSIR			
	2008		2007		**2008**		2007	
	R'000	**%**	R'000	%	**R'000**	**%**	R'000	%
2 REVENUE								
Parliamentary Grant	**429 013**	**34**	428 055	38	**429 013**	**35**	428 055	39
Parliamentary Grant received	**445 046**	**36**	423 854	37	**445 046**	**37**	423 854	38
Less:								
Grant received for projects started before year end but not completed	**(43 112)**	**(4)**	(27 079)	(2)	**(43 112)**	**(4)**	(27 079)	(2)
Add:								
Grant received in prior year for projects completed in this year	**27 079**	**2**	31 280	3	**27 079**	**2**	31 280	3
National Metrology Laboratory grant	**–**	**–**	32 388	3	**–**	**–**	32 388	3
Contract income	**776 908**	**65**	660 587	58	**766 046**	**65**	643 677	58
Private sector	**137 858**	**11**	134 111	12	**137 683**	**11**	134 647	12
Public sector	**508 779**	**43**	403 003	35	**508 779**	**43**	403 003	36
International sector (including Africa)	**130 271**	**11**	123 473	11	**119 584**	**11**	106 027	10
Royalties	**16 458**	**1**	22 155	1	**9 070**	**–**	10 808	–
	1 222 379	**100**	1 143 185	100	**1 204 129**	**100**	1 114 928	100

Contract income is disclosed after taking into account the effect of the time value of money in terms of Circular 9 of 2006: Transactions giving rise to adjustments to revenue/purchases. The value is R11,425 million (2007: R10,179 million).

Included in public sector contract income is a R59,181 million (2007: R nil) ring-fenced allocation from the Department of Science and Technology for specific initiatives managed through memorandums of agreement.

Estimates on Parliamentary Grant recognition are based on cost to completion, budgets and percentage of completion.

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

3 OPERATING PROFIT

The net operating profit is arrived at after taking the following items into account:

Auditors' remuneration	**3 080**	2 613	**3 023**	2 410
Audit fees	**3 080**	2 613	**3 023**	2 410
Fees for services	**4 285**	4 022	**3 426**	3 569
Patent costs	**3 621**	2 962	**2 948**	2 770
Legal costs	**664**	1 060	**478**	799
Operating leases	**15 120**	14 046	**15 089**	13 998
Buildings	**5 327**	4 258	**5 296**	4 224
Equipment	**7 332**	7 545	**7 332**	7 531
Vehicles	**2 461**	2 243	**2 461**	2 243
Net realised foreign exchange gain	**(5 022)**	(7 715)	**(4 907)**	(6 899)
Net unrealised foreign exchange (gain)/loss	**(8 402)**	418	**(8 402)**	418
Board members' and executive management's emoluments (note 19)	**12 894**	13 767	**9 181**	11 278
(Reversals of impairments)/impairments	**(1 849)**	17 552	**(5 497)**	12 516
Impairment on loans to subsidiaries, joint ventures and associates	**1 415**	19 587	**1 601**	24 031
Reversal of impairment on subsidiaries, joint ventures and associates	**–**	–	**(3 133)**	(9 401)
Reversal of impairment on trade receivables	**(4 381)**	(2 114)	**(4 379)**	(2 114)
Impairment on intangible assets	**703**	79	**–**	–
Impairment on property, plant and equipment	**414**	–	**414**	–
Provision for bonuses and leave	**45 527**	42 552	**45 527**	42 552
Lost and/or stolen equipment	**313**	527	**313**	527
Bad debt written off	**1 332**	2 444	**1 323**	2 436
Equipment written off	**79**	68	**79**	68
Write-down of inventory to net realisable value	**268**	–	**268**	–
Theft and/or damage to hired vehicles	**963**	585	**963**	585
Loss on disposal and write-off of property, plant and equipment	**6 302**	1 268	**6 298**	1 556
(Profit)/loss on disposal and deregistration of interest in subsidiary	**(823)**	4	**–**	–

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

4 FINANCE INCOME/EXPENSE

Finance income	**61 271**	36 588	**59 755**	35 717
Interest on bank balances and investments	**49 846**	26 409	**48 330**	25 538
Adjustment on initial recognition of contract income*	**11 425**	10 179	**11 425**	10 179
Finance expense	**(6 421)**	(6 376)	**(6 414)**	(6 285)
Interest paid on loans and liabilities	**(7)**	(91)	**–**	–
Fair value adjustment on trade and other receivables	**246**	406	**246**	406
Adjustment on initial recognition of operating expenses*	**(6 660)**	(6 691)	**(6 660)**	(6 691)
	54 850	30 212	**53 341**	29 432

*These adjustments are due to the effect of the time value of money in terms of Circular 9 of 2006: Transactions giving rise to adjustments to revenue/purchases.

5 INCOME TAX EXPENSE

The CSIR and its subsidiary, the South African Inventions Development Corporation (SAIDCOR), are exempt from South African income tax.

South African normal taxation	**–**	–
Current taxation: current year	**–**	–
Current taxation: prior year	**–**	–
Foreign taxation	**(135)**	103
Current taxation	**(122)**	109
Deferred taxation – temporary differences	**(13)**	(6)
	(135)	103
South African normal rate of taxation	**29%**	29%
Profit attributable to tax exempt entities	**(26%)**	(32%)
Assessed loss	**(3%)**	3%
Effect of foreign taxation	**–**	–
Current and deferred taxation – effective rate	**–**	–

6 PROPERTY, PLANT AND EQUIPMENT

	2008			2007		
	Cost	**Accumulated depreciation**	**Carrying value**	Cost	Accumulated depreciation	Carrying value
	R'000	**R'000**	**R'000**	R'000	R'000	R'000
Group						
Land	**5 549**	**–**	**5 549**	5 549	–	5 549
Buildings	**189 256**	**79 717**	**109 539**	193 300	82 588	110 712
Equipment	**485 677**	**377 244**	**108 433**	473 151	372 092	101 059
Vehicles	**5 830**	**3 922**	**1 908**	5 513	3 978	1 535
	686 312	**460 883**	**225 429**	677 513	458 658	218 855
CSIR						
Land	**5 549**	**–**	**5 549**	5 549	–	5 549
Buildings	**189 256**	**79 717**	**109 539**	193 300	82 588	110 712
Equipment	**484 074**	**375 952**	**108 122**	471 754	371 065	100 689
Vehicles	**5 830**	**3 922**	**1 908**	5 513	3 978	1 535
	684 709	**459 591**	**225 118**	676 116	457 631	218 485

6 PROPERTY, PLANT AND EQUIPMENT (continued)

	Land R'000	Buildings R'000	Equipment R'000	Vehicles R'000	Total R'000
Group					
Carrying value 31 March 2006	5 549	198 215	94 939	808	**299 511**
Additions	–	7 880	56 902	1 202	**65 984**
Disposals and write-offs	–	(412)	(1 216)	(68)	**(1 696)**
Depreciation	–	99	(49 646)	(407)	**(49 954)**
Exchange differences	–	–	80	–	**80**
Transfer to non-current asset classified as held for sale	–	(95 070)	–	–	**(95 070)**
Carrying value 31 March 2007	5 549	110 712	101 059	1 535	**218 855**
Additions	–	4 810	35 789	576	**41 175**
Disposals and write-offs	–	(5 784)	(576)	–	**(6 360)**
Depreciation	–	(199)	(27 463)	(203)	**(27 865)**
Exchange differences	–	–	38	–	**38**
Impairment	–	–	(414)	–	**(414)**
Carrying value 31 March 2008	**5 549**	**109 539**	**108 433**	**1 908**	**225 429**
CSIR					
Carrying value 31 March 2006	5 549	198 215	94 664	808	**299 236**
Additions	–	7 880	56 721	1 202	**65 803**
Disposals and write-offs	–	(412)	(1 203)	(68)	**(1 683)**
Depreciation	–	99	(49 493)	(407)	**(49 801)**
Transfer to non-current asset classified as held for sale	–	(95 070)	–	–	**(95 070)**
Carrying value 31 March 2007	5 549	110 712	100 689	1 535	**218 485**
Additions	–	4 810	35 697	576	**41 083**
Disposals and write-offs	–	(5 784)	(570)	–	**(6 354)**
Depreciation	–	(199)	(27 280)	(203)	**(27 682)**
Impairment	–	–	(414)	–	**(414)**
Carrying value 31 March 2008	**5 549**	**109 539**	**108 122**	**1 908**	**225 118**

6 PROPERTY, PLANT AND EQUIPMENT (continued)

Land and buildings are unencumbered and full details of the titles are available at the registered office of the CSIR.

A change in the depreciation estimate due to a change in the useful lives of equipment and vehicles resulted in a R11,55 million and R264 221 decrease in the respective depreciation amounts for the current financial year (2007: R nil).

Included above are assets with a cost of R245,7 million (2007: R268,0 million) that are fully depreciated as the remaining useful life is incidental.

At year-end assets with a cost of R58,3 million (2007: R13,4 million) were purchased with Parliamentary Grant funds and are shown at a nil carrying value.

6.1 Non-current asset held for sale

A building of R94,89 million is in the process of being transferred to the Department of Science and Technology.

The sale of the building is subject to a suspensive condition relating to the rezoning of the property. The expected date for fulfilment is October 2008. Transfer of title will commence thereafter.

7 INTANGIBLE ASSETS

	2008			2007		
	Cost	**Accumulated amortisation**	**Carrying value**	Cost	Accumulated amortisation	Carrying value
	R'000	**R'000**	**R'000**	R'000	R'000	R'000
Group						
Investments in technology	**8 915**	**8 915**	**–**	8 296	8 016	280
CSIR						
Investments in technology	**–**	**–**	**–**	–	–	–

	GROUP	CSIR
	R'000	**R'000**
Carrying value 31 March 2006	628	–
Additions	459	–
Disposals	–	–
Impairment	(79)	–
Amortisation	(728)	–
Carrying value 31 March 2007	280	–
Additions	619	–
Disposals	–	–
Impairment	(703)	–
Amortisation	(196)	–
Carrying value 31 March 2008	**–**	**–**

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

8 INTEREST IN JOINT VENTURES AND ASSOCIATES

Cost of investments less impairment losses	**41**	41	**1**	1
Loans to joint ventures and associates	**35 518**	34 045	**35 558**	34 085
Share of post-acquisition losses	**(17 247)**	(17 189)	**–**	–
	18 312	16 897	**35 559**	34 086
Impairment of joint ventures and associates	**(18 312)**	(16 897)	**(35 558)**	(34 085)
	–	–	**1**	1

Agreements have been entered into between the CSIR and certain joint ventures and associates to subordinate the loans made to those joint ventures and associates. The subordination agreements will remain in force for as long as the liabilities of the relevant joint ventures or associates exceed their assets, fairly valued.

Details of the joint ventures and associates at 31 March 2008 are as follows:

Name of joint venture/associate	Place of incorporation	Portion of ownership interest	Portion of voting power held	Principal activity	Carrying value 2008 R'000	Carrying value 2007 R'000	Financial year end
Joint ventures							
Mbuyu Biotech (Pty) Ltd	South Africa	50%	50%	Development and trading in biotechnology and expertise	**196**	285	31 March
Sera (Pty) Ltd	South Africa	50%	50%	Commercialisation and licensing of patents	**17 135**	16 363	31 March
Ellipsoid Technology (Pty) Ltd	South Africa	50%	50%	Development of encapsulation technology	**981**	249	31 March
Associates							
AIDC Development Centre Eastern Cape (Pty) Ltd	South Africa	25%	25%	Automotive industry development and support services	**–**	–	31 March
Eyeborn (Pty) Ltd	South Africa	26%	26%	Holding, licensing and exploitation of intellectual property technology	**–**	–	31 March
					18 312	16 897	

8 INTEREST IN JOINT VENTURES AND ASSOCIATES (continued)

The following are details of the significant joint ventures' and associates' assets, liabilities, income and expenses:

	JOINT VENTURES GROUP		ASSOCIATES GROUP	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000
Current assets	**33 389**	42 120	**3 584**	3 281
Long-term assets	**5 259**	3 887	**316**	257
Current liabilities	**3 633**	11 544	**3 429**	2 134
Long-term liabilities	**68 134**	69 826	**3 347**	4 224
Income	**9 854**	6 355	**13 399**	14 497
Expenses	**9 739**	10 702	**13 451**	14 506

9 INTEREST IN SUBSIDIARIES

	CSIR	
	2008	2007
	R'000	R'000
Shares at cost less impairment losses	**4 650**	23 212
Indebtedness	**11 624**	(5 097)
– by subsidiaries	**28 557**	20 187
– impairment of loans	**(16 933)**	(16 805)
– to subsidiaries	**–**	(8 479)
	16 274	18 115

Details disclosed in Addendum A.

The loans to subsidiaries are interest free, unsecured and have no fixed terms of repayment.

Agreements have been entered into between the CSIR and certain subsidiaries to subordinate the loans made to those subsidiaries. The subordination agreements will remain in force for as long as the liabilities of the relevant subsidiaries exceed their assets, fairly valued.

	GROUP		CSIR	
	2008 R'000	2007 R'000	**2008** R'000	2007 R'000

10 OTHER INVESTMENTS

	% held	Number of shares held **2008**	Number of shares held 2007	Class of shares	GROUP **2008** R'000	GROUP 2007 R'000	CSIR **2008** R'000	CSIR 2007 R'000
Unlisted shares					–	–	–	–
Breathetex (Pty) Ltd	**20,1**	**12 000**	12 000	Ordinary	**11 025**	11 025	**11 025**	11 025
Breathetex (Pty) Ltd		**11 680**	11 680	Preference	**–**	–	**–**	–
Accumulated impairment losses					**(11 025)**	(11 025)	**(11 025)**	(11 025)
Fixed deposits					–	200 000	–	200 000
					–	200 000	**–**	200 000

11 TRADE AND OTHER RECEIVABLES

	GROUP **2008** R'000	GROUP 2007 R'000	CSIR **2008** R'000	CSIR 2007 R'000
Trade receivables	**141 031**	132 246	**135 810**	127 025
Prepaid expenditure	**118 707**	9 625	**118 707**	9 625
Other receivables	**7 338**	5 035	**7 155**	4 956
	267 076	146 906	**261 672**	141 606

Trade receivables are shown net of impairment losses. Refer to note 23 for more detail on trade receivables.

12 INVENTORY AND CONTRACTS IN PROGRESS

	GROUP **2008** R'000	GROUP 2007 R'000	CSIR **2008** R'000	CSIR 2007 R'000
Inventory	**3 468**	938	**3 468**	938
Contracts in progress less provision for losses	**58 244**	42 265	**58 244**	42 265
	61 712	43 203	**61 712**	43 203

Estimates on contract in progress recognition are based on cost to completion, budgets and percentage of completion. The write-down of inventory to net realisable value amounted to R268 000 (2007: R nil).

13 DEFERRED TAX LIABILITIES

	GROUP **2008** R'000	GROUP 2007 R'000
Balance at the beginning of the year	**13**	19
Accelerated capital allowances	**(13)**	(6)
	–	13

14 ADVANCES RECEIVED

	GROUP **2008** R'000	GROUP 2007 R'000	CSIR **2008** R'000	CSIR 2007 R'000
Advances on contracts received from clients	**448 854**	356 576	**448 854**	356 576

Included in advances received is an amount of R116,8 million excluding VAT (2007: R133,1 million (including VAT)) that relates to the transfer of the building to the Department of Science and Technology (refer note 6.1 and note 29).

15 TRADE AND OTHER PAYABLES

	GROUP **2008** R'000	GROUP 2007 R'000	CSIR **2008** R'000	CSIR 2007 R'000
Accounts payable and accruals	**413 807**	294 253	**411 909**	287 889

		Opening balance R'000	Additional provisions R'000	Utilised and reversed R'000	**Closing balance R'000**
16	**PROVISIONS**				
	GROUP				
	Leave pay and bonus provision The provision for leave pay is based on the actual number of leave days outstanding per employee. The provision for bonus is based on the principles of Value-based Performance bonus management. Value-based Performance bonus management combines the concept of economic performance and non-financial performance.	72 248	45 527	(41 180)	**76 595**
		72 248	45 527	(41 180)	**76 595**
	CSIR				
	Leave pay and bonus provision The provision for leave pay is based on the actual number of leave days outstanding per employee. The provision for bonus is based on the principles of Value-based Performance bonus management. Value-based Performance bonus management combines the concept of economic performance and non-financial performance.	72 248	45 527	(41 180)	**76 595**
		72 248	45 527	(41 180)	**76 595**

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

17 OPERATING LEASE COMMITMENTS

Financial commitments under non-cancellable operating leases will result in the following payments falling due:

Within one year:	**6 835**	5 579	**6 115**	5 579
Land and buildings	**5 199**	1 181	**4 479**	1 181
Equipment	**32**	2 710	**32**	2 710
Vehicles	**1 604**	1 688	**1 604**	1 688
Within two to five years:	**15 656**	4 018	**15 656**	4 018
Land and buildings	**13 564**	–	**13 564**	–
Equipment	**–**	1 289	**–**	1 289
Vehicles	**2 092**	2 729	**2 092**	2 729

Agreements relating to operating lease payments for equipment and vehicles vary between 12 and 60 months and are fixed for the term of the agreements.

The CSIR leases buildings under operating leases. The leases typically run for a period of five years. Lease payments are increased with a fixed annual escalation percentage to reflect market rentals. None of the leases includes contingent rentals.

18 RETIREMENT BENEFITS OF EMPLOYEES

18.1 CSIR Pension Fund

The fund is registered in terms of the Pension Funds Act, 1956, and is a defined contribution plan. The CSIR's liability to the fund is limited to paying the employer contributions. Life cover and dependants' pensions are fully secured by a continued income and life insurance policy. All the CSIR's permanent employees are members of the fund.

Employer contributions of R41,7 million (2007: R40,9 million) and employee contributions of R23,9 million (2007: R22,7 million) were paid over during the year. Employer contributions are charged against income when incurred.

18.2 Mine Officials Pension Fund and Sentinel

At the time of the merger with the Chamber of Mines Research Organisation (COMRO) in 1993, certain COMRO (Sentinel Mining) employees elected to remain members of the Mine Officials Pension Fund (one member) and Sentinel (three members) (previously Chamber of Mines Pension Fund). In terms of the agreement with the Chamber of Mines, this election holds no liability for the CSIR other than paying the monthly employee contributions. The funds are defined benefit plans.

On 1 March 2001 the members of the Chamber of Mines Pension Fund moved to Sentinel.

In respect of the employees who had formally converted their secondment to a CSIR appointment, employer contributions of R174 608 (2007: R165 852) and employee contributions of R95 869 (2007: R91 067) were paid over during the year. Employer contributions are charged against income when incurred.

18.3 Associated Institutions Pension Fund (AIPF)

The fund is a defined benefit plan. The formula used to determine pensions is based on the pensionable earnings of the final year, and the aggregate period of uninterrupted membership.

The CSIR has two employees (2007: two employees) who are members of the AIPF. The fund is controlled by the state, which has assumed responsibility for the unfunded portions of these funds.

Employer contributions of R7 543 (2007: R7 262) and employee contributions of R4 715 (2007: R4 538) were paid over during the year to the AIPF.

18.4 Post-retirement medical benefits

The CSIR formed its own Medical Aid Scheme, based on managed health care principles, with a strong emphasis on co-responsibility between the fund and its members. The objective is to provide sustainable health care and simultaneously limit the cost, present and future, to a level that is affordable. The CSIR Board approved a cash payment of R190 million in 1997 to the Medical Aid Scheme, thereby transferring the liability for retirement benefits of members to the scheme. Due to changes in the Medical Schemes Act of 1998, the scheme can no longer accept the liability for retirement benefits of qualifying members of the scheme.

The accumulated benefit obligation and the annual cost of accrual of benefits are assessed by independent, qualified actuaries using the projected unit credit method. Subsequent to 2006/07, another 29 members were traced and their liabilities settled. The estimated present value of the anticipated expenditure for the remaining 26 continuation members was recalculated by the actuaries as at 31 March 2008 and will be funded through cash and cash equivalents.

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

18 RETIREMENT BENEFITS OF EMPLOYEES (continued)

18.4 Post-retirement medical benefits (continued)

The amount included in the balance sheet arising from the CSIR's obligation in respect of post-retirement medical benefits is as follows:

Present value of obligations	**8 595**	12 751	**8 595**	12 751
Net liability on balance sheet	**8 595**	12 751	**8 595**	12 751

Amounts recognised in income in respect of the scheme are as follows:

Interest cost	**858**	960	**858**	960
Actuarial (gain)/loss recognised during the year	**(955)**	2 681	**(955)**	2 681
Total	**(97)**	3 641	**(97)**	3 641

Movement in the net liability recognised in the balance sheets is as follows:

Net liability at the beginning of the year	**12 751**	14 897	**12 751**	14 897
	(4 156)	(2 146)	**(4 156)**	(2 146)
Net (income)/expense recognised in the income statement	**(97)**	3 641	**(97)**	3 641
Settlements	**(4 059)**	(5 787)	**(4 059)**	(5 787)
Net liability at the end of the year	**8 595**	12 751	**8 595**	12 751
Actual return on investments/plan assets	**9.50%**	7.60%	**9.50%**	7.60%

Principal actuarial assumptions at the balance sheet date

Discount rate at 31 March	**9.70%**	8.00%	**9.70%**	8.00%
Medical inflation costs	**5.48%**	3.85%	**5.48%**	3.85%

Historical information	**2008**	2007	2006	2005	2004
Present value of the defined benefit obligation	**8 595**	12 751	14 897	380 992	371 222
Fair value of plan assets	**–**	–	–	(273 685)	(222 998)
Deficit in the plan	**8 595**	12 751	14 897	107 307	148 224

19 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION

	Entity	Fees for services as director R'000	Managerial Services: Basic salary R'000	Managerial Services: Bonuses and performance-related payments R'000	Managerial Services: Retirement fund and medical aid contributions R'000	Total
Board members and Executive Directors						
Dr S Sibisi	CSIR	–	2 056	655	347	**3 058**
Foreign subsidiaries						
Dr A Hickman	Quotec Limited (UK)	–	1 240	502	10	**1 752**
Dr JR Galsworthy	Quotec Limited (UK)	–	660	143	5	**808**
Mr AA Davidson	Quotec Limited (UK)	–	1 010	143	–	**1 153**
Remunerated in British pound						
Non-executive Board members						
Ms N Shikwane	CSIR	27	–	–	–	**27**
Professor C de la Rey	CSIR	16	–	–	–	**16**
Dr N Msomi	CSIR	18	–	–	–	**18**
Professor M Wingfield	CSIR	14	–	–	–	**14**
Dr N Dlamini	CSIR	9	–	–	–	**9**
Dr F Petersen	CSIR	11	–	–	–	**11**
Professor DR Hall	CSIR	9	–	–	–	**9**
Mr EH Mayet	CSIR	14	–	–	–	**14**
Professor B Gourley	CSIR	3	–	–	–	**3**
Executive Management						
Dr JH Maree	CSIR	–	1 141	487	170	**1 798**
Ms K Njobe	CSIR	–	1 114	361	137	**1 612**
Mr CR Sturdy	CSIR	–	1 061	106	95	**1 262**
Mr RM Zondo	CSIR	–	953	129	91	**1 173**
Dr T Dlamini (interim: since Feb 08)	CSIR	–	146	–	11	**157**
2008		**121**	**9 381**	**2 526**	**866**	**12 894**

19 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION (continued)

	Entity	Fees for services as director	Managerial Services			Total
			Basic salary	Bonuses and performance-related payments	Retirement fund and medical aid contributions	
		R'000	R'000	R'000	R'000	
Board members and Executive Directors						
Dr S Sibisi	CSIR	–	1 751	744	312	2 807
Foreign subsidiaries						
Dr NA Waterman (up to Nov 06)	Quotec Limited (UK)	–	102	–	–	102
Dr A Hickman	Quotec Limited (UK)	–	1 160	307	8	1 475
Dr JR Galsworthy	Quotec Limited (UK)	–	638	94	6	738
Mr AA Davidson (since Nov 06)	Quotec Limited (UK)	–	174	–	–	174
Remunerated in British pound						
Non-executive Board members						
Ms N Shikwane	CSIR	26	–	–	–	26
Professor C de la Rey	CSIR	13	–	–	–	13
Dr N Msomi	CSIR	12	–	–	–	12
Professor M Wingfield	CSIR	10	–	–	–	10
Dr N Dlamini (since January 06)	CSIR	5	–	–	–	5
Dr F Petersen (since January 06)	CSIR	10	–	–	–	10
Professor DR Hall (since August 06)	CSIR	3	–	–	–	3
Mr EH Mayet (since August 06)	CSIR	9	–	–	–	9
Executive Management						
Mr AJ Jordaan (up to July 06) *	CSIR	–	1 956	1 694	73	3 723
Mr VP Pillay (up to June 06) **	CSIR	–	323	132	41	496
Dr JH Maree (since August 06)	CSIR	–	707	546	105	1 358
Ms K Njobe (since May 06)	CSIR	–	955	500	120	1 575
Mr CR Sturdy (since Aug 06)	CSIR	–	570	–	34	604
Mr RM Zondo (since Aug 06)	CSIR	–	578	–	49	627
2007		88	8 914	4 017	748	13 767

* Including severance and leave payout

** Including leave payout

20 INSURANCE AND RISK MANAGEMENT

The insurance and risk management policies adopted by the CSIR are aimed at obtaining sufficient cover at the minimum cost to protect its asset base, earning capacity and legal obligations against unacceptable losses.

All property, plant and equipment are insured at current replacement value. Risks of a possible catastrophic nature are identified and insured while acceptable risks of a non-catastrophic nature are self-insured. Self-insurance has been instituted where the cost-to-benefit relationship exceeds the risk and the incidence of losses is of a minor and infrequent nature. Self-insured risks are reviewed on an annual basis to ensure cover is adequate. An amount of R10,75 million (2007: R10,75 million) is held in a self-insurance fund to cover these risks. This amount is disclosed as part of reserves in the balance sheet. No major losses were experienced during the year under review. Claims of a general nature were adequately covered.

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

21 CONTINGENT LIABILITIES AND FACILITIES

Bank guarantees issued in respect of third party liabilities	**17 000**	17 000	**17 000**	17 000

Legal costs and litigation:
In the nature of the CSIR's business, agreements with complex deliverables may be entered into. All necessary steps are taken to manage the risks inherent to these transactions. If and when it is evident that there is a reasonable probability that a dispute on a transaction could lead to costs against the CSIR, such costs will be disclosed.

22 CAPITAL COMMITMENTS

Authorised but not contracted	**32 069**	18 714	**32 069**	18 714

This capital expenditure is to be financed from internal sources.

23 FINANCIAL INSTRUMENTS

The Group has exposure to the following risks from its use of financial instruments:
- market risk
- credit risk
- liquidity risk.

This note presents information about the Group's exposure to each of the above risks and the Group's objectives, policies and processes for measuring and managing risk. Further quantitative disclosures are included throughout these consolidated financial statements.

The Board has overall responsibility for the establishment and oversight of the Group's risk management framework.

The Group's risk management policies are established to identify and analyse the risks faced by the Group, to set appropriate risk limits and controls, and to monitor risks and adherence to limits. Risk management policies and systems are reviewed regularly to reflect changes in market conditions and the Group's activities. The Group, through its training and management standards and procedures, aims to develop a disciplined and constructive control environment in which all employees understand their roles and obligations.

The Audit Committee oversees how management monitors compliance with the Group's risk management policies and procedures and reviews the adequacy of the risk management framework in relation to the risks faced by the Group. The Group Audit Committee is assisted in its oversight role by Internal Audit. Internal Audit undertakes both regular and *ad hoc* reviews of risk management controls and procedures, the results of which are reported to the Audit Committee.

23 FINANCIAL INSTRUMENTS (continued)

23.1 Market risk

Foreign currency risk

The Group is exposed to currency risk on sales and purchases that are denominated in a currency other than the respective functional currencies of Group entities, primarily the rand, and on investments in foreign operations.

The Group enters into forward exchange contracts to buy specified amounts of foreign currencies in the future at a predetermined exchange rate.

Forward exchange contracts are entered into mainly to cover import orders. The Group has no policy to enter into forward exchange contracts for anticipated foreign receipts. The Group does not use derivative financial instruments for speculative purposes.

The Group's exposure to foreign currency risk was as follows, based on notional amounts:

	31 MARCH 2008					
	Total R'000	**ZAR R'000**	**EURO R'000**	**USD R'000**	**GBP R'000**	**Other R'000**
Trade receivables	**141 031**	108 033	3 770	22 825	5 952	451
Bank accounts	**40 843**	25 629	5 851	5 097	3 724	542
Trade payables	**(413 807)**	(412 360)	–	–	(1 447)	–
Gross balance sheet exposure	**(231 933)**	(278 698)	9 621	27 922	8 229	993
Forward exchange contracts	**(53 975)**	–	(40 831)	(12 508)	(636)	–
Net exposure	**(285 908)**	**(278 698)**	**(31 210)**	**15 414**	**7 593**	**993**

	31 MARCH 2007					
	Total R'000	ZAR R'000	EURO R'000	USD R'000	GBP R'000	Other R'000
Trade receivables	132 246	114 500	2 470	6 431	7 717	1 128
Bank accounts	62 186	48 204	3 200	5 880	4 646	256
Trade payables	(294 253)	(290 827)	–	–	(3 426)	–
Gross balance sheet exposure	(99 821)	(128 123)	5 670	12 311	8 937	1 384
Forward exchange contracts	(8 057)	–	(2 136)	(1 811)	(4 110)	–
Net exposure	(107 878)	(128 123)	3 534	10 500	4 827	1 384

	GROUP	
	2008	2007

23 FINANCIAL INSTRUMENTS (continued)

23.1 Market risk (continued)

Foreign currency risk (continued)

The following significant exchange rates applied during the year

Average rate of forward exchange contracts:	**R**	R
Euro	**13.1452**	9.6910
USD	**8.1956**	7.2650
GBP	**16.3646**	14.2570
Year-end spot rate:		
Euro	**12.4712**	9.4564
USD	**7.8933**	7.1030
GBP	**15.6815**	13.9633

Sensitivity analysis

A 10% strengthening of the rand against the following currencies at 31 March would have increased/(decreased) profit or loss by the amounts shown below. This analysis assumes that all other variables remain constant. The analysis is performed on the same basis for 2007.

	R'000	R'000
Euro	**3 121**	(353)
USD	**(1 541)**	(1 050)
GBP	**(759)**	(483)

A 10% weakening of the rand against the above currencies at 31 March would have had the equal but opposite effect on the above currencies to the amounts shown above, on the basis that all other variables remain constant.

Interest rate risk

Interest rate exposure and investment strategies are evaluated by management on a regular basis. Interest-bearing investments are held with several reputable banks in order to minimise exposure.

At the reporting date the interest rate profile of the Group's interest-bearing financial instruments was:

Fixed rate instruments: carrying amount

	R'000	R'000
Financial assets	**650 255**	516 755

The Group does not account for any fixed rate financial assets and liabilities at fair value through profit or loss, and the Group does not designate derivatives (interest rate swaps) as hedging instruments under a fair value hedge accounting model. Therefore, a change in interest rates at the reporting date would not affect profit or loss.

23 FINANCIAL INSTRUMENTS (continued)

23.2 Credit risk

Credit risk is the risk of financial loss to the Group if a customer or counterparty to a financial instrument fails to meet its contractual obligations, and arises principally from the Group's bank balances and deposits, trade and other receivables and loans to joint ventures, associates and subsidiaries.

Trade and other receivables and loans to joint ventures, associates and subsidiaries

Trade and other receivables and loans to joint ventures, associates and subsidiaries are presented net of impairment losses. Credit risk with respect to trade receivables is limited due to the large number of customers comprising the Group's customer base and their dispersion across different industries and geographical areas. Accordingly, the Group does not have a significant concentration of credit risk.

The carrying amounts of financial assets included in the balance sheet represent the Group's exposure to credit risk in relation to these assets.

The Group does not have any significant exposure to any individual customer or counterparty.

Bank balances and deposits

The Group's bank balances and cash are placed with high credit, quality financial institutions.

Guarantees

Refer to note 21 for details on bank guarantees issued.

	GROUP	
Exposure to credit risk	**2008**	2007
	R'000	R'000
The carrying amount of financial assets represents the maximum credit exposure. The maximum exposure to credit risk at the reporting date was:		
Held-to-maturity investments	**650 255**	516 755
Loans and receivables	**325 320**	189 171
Cash and cash equivalents	**41 221**	62 488
Other forward exchange contracts	**5 040**	–
	1 021 836	768 414
The maximum exposure to credit risk for trade receivables at the reporting date by type of customer was:		
Public	**57 520**	67 479
Private	**49 371**	42 556
International	**34 140**	22 211
	141 031	132 246

23 FINANCIAL INSTRUMENTS (continued)

23.2 Credit risk (continued)

The Group's most significant customers are government institutions.

	2008		2007	
	Gross R'000	**Impairment R'000**	Gross R'000	Impairment R'000
The aging of the Group's trade receivables at the reporting date was:				
Not past due	**100 109**	**3 640**	104 261	4 966
Past due 0–30 days	**17 476**	**146**	14 764	7
Past due 31–120 days	**26 218**	**2 279**	16 891	1 837
Past due more than 120 days	**9 264**	**5 971**	12 745	9 605
	153 067	**12 036**	148 661	16 415

	GROUP	
	2008 R'000	2007 R'000
The movement in the allowance for impairment in respect of trade receivables during the year was as follows:		
Balance at 1 April	**16 415**	29 321
Impairment loss recognised	**(4 379)**	(12 906)
Balance at 31 March	**12 036**	16 415

The allowance account in respect of trade receivables is used to record impairment losses unless the Group is satisfied that no recovery of the amount owing is possible; at that point the amount considered irrecoverable is written off against the financial asset directly.

The movement in the impairment allowance account is due mainly to the following: recoveries of R8,8 million, utilisation of R5,0 million and new impairment allowances of R9,8 million.

23 FINANCIAL INSTRUMENTS (continued)

23.3 Liquidity risk

Liquidity risk is the risk that the Group will not be able to meet its financial obligations as these fall due. The Group's approach to managing liquidity is to ensure, as far as possible, that it will always have sufficient liquidity to meet its liabilities when due, under both normal and stressed conditions, without incurring unacceptable losses or risking damage to the Group's reputation.

The Group monitors its cash flow on a daily basis. Typically, the Group ensures that it has sufficient cash on demand to meet expected operational expenses for a period of 60 days, including the servicing of financial obligations; this excludes the potential impact of extreme circumstances that cannot be predicted reasonably, such as natural disasters.

The CSIR has a short-term general banking facility of R6,1 million available.

The following are the contractual maturities of financial liabilities, including interest payments and excluding the impact of netting agreements for the Group:

	2008			2007		
	Carrying amount	**Contractual cash flows**		Carrying amount	Contractual cash flows	
		6 months or less	**6–12 months**		6 months or less	6–12 months
	R'000	**R'000**	**R'000**	R'000	R'000	R'000
Non-derivative financial liabilities						
Trade and other payables*	**(413 807)**	**(413 807)**	**–**	(294 253)	(294 253)	–
Derivative financial liabilities						
Forward exchange contracts	**(48 935)**	**(40 836)**	**(8 099)**	(8 101)	(8 101)	–
	(462 742)	**(454 643)**	**(8 099)**	(302 354)	(302 354)	–

* Excludes construction work in progress (shown separately)

Rate of forward exchange contracts:

	GROUP	
	2008	2007
	R	R
Euro	**11.6684**	9.6520
USD	**7.9688**	7.2674
GBP	**13.6110**	14.4407

23 FINANCIAL INSTRUMENTS (continued)

23.4 Fair values

At 31 March 2008 the carrying amount of bank balances and cash, deposits, trade and other receivables, contracts in progress and trade and other payables approximated their fair values due to the short-term maturities of these assets and liabilities.

Basis for determining fair values

Interest free employee loans

The fair value of interest free employee loans is calculated based on the present value of future cash flows, discounted at the market rate of interest at the reporting date.

Trade and other receivables and trade and other payables

The fair value of trade and other receivables and trade and other payables is calculated based on the present value of future cash flows, discounted at the average return on investment rate at the reporting date.

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

24 RECONCILIATION OF OPERATING PROFIT TO CASH GENERATED BY OPERATIONS

Operating profit for the year before taxation	**54 141**	26 636	**51 740**	21 644
Adjusted for:				
(Profit)/loss on disposal of interest in subsidiary	**(823)**	4	**–**	–
Depreciation and amortisation	**28 061**	50 682	**27 682**	49 801
Net unrealised foreign exchange (gain)/loss	**(8 402)**	418	**(8 402)**	418
Net finance income	**(54 850)**	(30 212)	**(53 341)**	(29 432)
Post-retirement medical benefits	**(97)**	2 361	**(97)**	2 361
Straight-lining adjustment of operating leases	**54**	(486)	**54**	(486)
Provision for bonuses and leave	**45 527**	42 552	**45 527**	42 552
Impairments	**(1 849)**	17 552	**(5 497)**	12 516
Loss on disposal and write-off of property, plant and equipment	**6 302**	1 268	**6 298**	1 556
Share of loss of joint ventures and associates	**58**	999	**–**	–
Bad debt written off	**1 332**	2 444	**1 323**	2 436
Write-down of inventory to net realisable value	**268**	–	**268**	–
Operating profit before changes in working capital	**69 722**	114 218	**65 555**	103 366
(Increase)/decrease in trade and other receivables	**(108 125)**	11 320	**(108 685)**	13 491
(Increase)/decrease in inventory and contracts in progress	**(20 170)**	3 663	**(20 170)**	3 663
Increase in advances received	**94 546**	184 115	**94 546**	184 115
Increase in trade and other payables and provisions	**78 500**	12 485	**82 966**	7 696
Net working capital changes	**44 751**	211 583	**48 657**	208 965
Cash generated by operations	**114 473**	325 801	**114 212**	312 331

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000
25 CASH AND CASH EQUIVALENTS				
Cash on deposit	**650 486**	316 909	**646 731**	313 154
Bank balances	**40 843**	62 186	**26 431**	44 227
Cash on hand	**147**	148	**147**	148
	691 476	379 243	**673 309**	357 529

26 RELATED PARTY TRANSACTIONS

The CSIR is one of 29 schedule 3B National Government Business Enterprises in terms of the Public Finance Management Act, Act 1 of 1999 as amended by Act 29 of 1999, and therefore falls within the national sphere of government. As a consequence, the CSIR has a significant number of related parties being entities that fall within the national sphere of government.

In addition, the CSIR has a related party relationship with its subsidiaries (see Addendum A) and joint ventures and associates (see note 8). Unless specifically disclosed, these transactions are concluded at arm's length and the Group is able to transact with any entity.

	GROUP		CSIR	
	2008	2007	**2008**	2007
	R'000	R'000	**R'000**	R'000

26 RELATED PARTY TRANSACTIONS (continued)

26.1 Transactions with related parties

The following is a summary of transactions with related parties during the year and balances due at year end:

Constitutional institutions				
Services rendered	**517**	1 973	**517**	1 973
Services received	**309**	343	**309**	343
Amount due from	**70**	424	**70**	424
Major public entities				
Services rendered	**140 986**	117 469	**140 986**	117 469
Services received	**16 087**	13 531	**16 087**	13 531
Amount due from	**9 767**	25 833	**9 767**	25 833
National public entities				
Services rendered	**38 055**	49 236	**38 055**	49 236
Services received	**141 321**	148 502	**141 321**	148 502
Amount due from	**5 154**	6 576	**5 154**	6 576
National government business enterprises				
Services rendered	**2 340**	2 204	**2 340**	2 204
Services received	**542**	4 600	**542**	4 600
Amount due from	**305**	319	**305**	319
Government departments				
Services rendered	**573 336**	595 659	**573 336**	595 659
Services received	**35**	161	**35**	161
Amount due from	**5 017**	10 858	**5 017**	10 858
Subsidiaries				
Services rendered	**–**	–	**834**	1 680
Services received	**–**	–	**1 713**	266
Amount due from/(to)	**–**	–	**7 128**	(4 659)
Associates				
Services rendered	**6 234**	6 631	**6 234**	6 631
Services received	**–**	110	**–**	110
Amount due (to)/from	**(428)**	3 120	**(428)**	3 120

26 RELATED PARTY TRANSACTIONS (contined)

26.2 Transactions with key management

There were no new loans to key management during the year (2007: R nil) and R nil (2007: R27 000) is included in other receivables (see note 11). No interest is payable by key management.

Total remuneration is included in employee remuneration (see note 19).

27 NATIONAL METROLOGY LABORATORY (NML)

In terms of the Measurement Units and Measurement Standards Act, Act 18 of 2006, the National Metrology Institute of South Africa (NMISA) was established as a separate public entity, the Executive Authority of which is the Minister of Trade and Industry. The commencement date of the Act, which co-incides with the date of the establishment of NMISA, was 1 May 2007, as per Proclamation R8, published in Government Gazette No 29833 of 26 April 2007.

Pursuant to the said Act, all rights, obligations and liabilities acquired or incurred by the CSIR National Metrology Laboratory (NML) vested in NMISA as from 1 May 2007 and similarly all employees of the former NML were transferred to NMISA.

	2008 R'000	2007 R'000
Profit attributable to the NML is as follows:		
Revenue	**2 604**	48 487
Employees remuneration	**(3 505)**	(22 267)
Operating expenses	**(731)**	(23 340)
(Loss)/profit for the year	**(1 632)**	2 880
Assets and liabilities attributable to the NML are as follows:		
Assets		
Current assets	**11 529**	17 341
Trade and other receivables	**1 716**	1 266
Bank balances and cash on hand	**9 813**	16 075
Total assets	**11 529**	17 341
Equity and liabilities		
Reserves	**9 262**	10 894
Retained earnings	**9 262**	10 894
Current liabilities	**2 267**	6 447
Advances received	**359**	758
Trade and other payables	**1 908**	4 666
Provisions	**–**	1 023
Total equity and liabilities	**11 529**	17 341
The net assets of NML on transfer were as follows:		
Net asset value transferred	**9 262**	
Total consideration	**9 262**	
Net cash outflow arising on transfer of NML		
Bank balance and cash disposed	**(9 813)**	

	GROUP	
	2008	2007
	R'000	R'000

28 DEREGISTRATION AND LIQUIDATION OF SUBSIDIARIES

28.1 Agrimage (Pty) Ltd

The Group held 100% of the issued share capital in Agrimage (Pty) Ltd. The company was deregistered on 4 August 2006.

The net assets of Agrimage (Pty) Ltd on deregistration were as follows:	
Net asset value disposed	4
Loss on deregistration	(4)
Total consideration	–
Net cash outflow arising on deregistration of interest in subsidiary	
Bank balance and cash disposed	–

28.2 CSIR International Limited

The Group held 100% of the issued share capital in CSIR International Limited. The company was deregistered on 1 May 2007.

The net assets of CSIR International Limited on deregistration were as follows:	
Net asset value disposed	**(739)**
Profit on deregistration	**739**
Total consideration	–
Net cash outflow arising on deregistration of interest in subsidiary	
Bank balance and cash disposed	–

28.3 Brilliant Security Solutions (Pty) Ltd

The Group held 100% of the issued share capital in Brilliant Security Solutions (Pty) Ltd. The company was liquidated.

The net assets of Brilliant Security Solutions (Pty) Ltd on liquidation were as follows:	
Net asset value disposed	**(84)**
Profit on liquidation	**84**
Total consideration	–
Net cash inflow arising on liquidation of subsidiary	
Liquidation dividend received	**154**

29 SUBSEQUENT EVENTS

29.1 Department of Science and Technology building

Negotiations to transfer the building as disclosed in note 6.1 are being finalised. An advance has been received as disclosed in note 14.

29.2 Technology Innovation Agency Bill

The Technology Innovation Agency Bill is currently in the process of being approved by Parliament. Upon the promulagtion of the Technology Innovation Agency Act, 2007, the Inventions Development Act, 1962, Act 31 of 1962, will simultaneously be repealed.

30 STANDARDS AND INTERPRETATIONS ISSUED, NOT YET EFFECTIVE

At the date of authorisation of the financial statements of the Group for the year ended 31 March 2008, the following standards and interpretations were in issue but not yet effective:

Standard/Interpretation	Description
IAS 1 (AC 101)	Presentation of financial statements. The Group will adopt the revised standard on its effective date. The revised standard will affect the disclosures in the annual report.
IFRS 2 (AC 139)	Share-based payment: vesting conditions and cancellations. The amendment will not affect the Group's results.
IFRS 3 (AC 140)	Business combinations. The revision is applicable prospectively and will not affect past business combinations.
IFRS 8 (AC 145)	Operating segments. The revision will not affect the Group's results.
IFRIC 12 (AC 445)	Service concession arrangements. IFRIC 12 is not expected to have any impact on the Group.
IFRIC 13 (AC 446)	Customer loyalty programmes. The interpretation will not affect the Group's results.
IFRIC 14 (AC 447)	IAS 19 – The limit on a defined benefit asset, minimum funding requirements and their interaction. No effect is anticipated on adoption of the interpretation.
IAS 23 (AC 114)	Borrowing costs. The revision is not expected to affect the Group's results.
IAS 27 (AC 132) amendment	Consolidated and separate financial statements. The revision is applicable prospectively and will not affect past business combinations.
IAS 32 (AC 125) and IAS 1 (AC 101) amendment	IAS 32 Financial instruments: presentation and IAS 1: Presentation of financial statements: puttable financial instruments and obligations arising on liquidation. The amendment will not affect the group.

Addendum A: Interest in subsidiaries

31 March 2008

Consolidated subsidiaries	Country of incorporation	Interests of the CSIR					
		Issued capital	Effective holding		Financial year end	Shares at cost less accumulated impairment losses	
			2008	2007		2008	2007
		R'000	%	%		R'000	R'000
Direct investments							
Technology Finance Corporation (Pty) Ltd (Technifin) (held as a SAIDCOR subsidiary in the prior financial year).	South Africa	**5 200**	**100**	–	31 March	**4 650**	–
Technovent (Pty) Ltd	South Africa	**5 000**	**100**	100	31 March	**–**	–
Quotec Limited	United Kingdom	**20**	**100**	100	31 March	**–**	–
CSIR International Limited*	British Virgin Island	**–**	**–**	100	31 March	**–**	–
South African Inventions Development Corporation (SAIDCOR)	South Africa	**27 220**	**100**	100	31 March	**–**	23 213
* No statutory audit was performed							
						4 650	23 213
Indirect investments							
Included in SAIDCOR:							
Technology Finance Corporation (Pty) Ltd (Technifin)	South Africa	**–**	**–**	100	31 March	**–**	4 650
Included in Technifin carrying value:							
Implico BV (incorporated in the Netherlands)	Netherlands/ South Africa	**71**	**100**	100	31 March	**–**	–

The Group has interests in five dormant companies. Details of these interests are available at the CSIR's registered office.

Interests of the CSIR							
Net indebtedness less accumulated impairment losses to subsidiaries		by subsidiaries		Net investment		General nature of business
2008 R'000	2007 R'000	**2008 R'000**	2007 R'000	**2008 R'000**	2007 R'000	
–	–	**7 409**	–	**12 059**	–	The acquisition and transfer of technology to industry by licensing new inventions, providing finance to develop technology and venture capital for the exploitation thereof.
–	–	–	–	–	–	The company sources technologies and entrepreneurs from the CSIR, other S&T institutions, universities or any developer of technology and develops these into viable businesses with the aim of spinning them off for capital gain and/or public good.
–	–	**4 215**	3 381	**4 215**	3 381	The principal activity of the company is that of consultants on technology auditing, technology evaluation and technology transfer on behalf of clients in the public and private sectors.
–	–	–	–	–	–	The company was dormant and has subsequently been deregistered.
–	8 479	–	–	–	14 734	The Inventions Development Act, 1962, Act 31 of 1962, will be repealed upon the promulagtion of the Technology Innovation Agency Act, 2007 and SAIDCOR will thereby be disestablished.
–	8 479	**11 624**	3 381	**16 274**	18 115	
						The acquisition and transfer of technology to industry by licensing new inventions, providing finance to develop technology and venture capital for the exploitation thereof.
						The company is in the process of being deregistered.
–	8 479	**11 624**	3 381	**16 274**	18 115	

Abbreviations

ACCESS	African Centre for Climate and Earth System Science
AFIS	Advanced Fire Information System
AFSSA	Action for a Safe South Africa
AIDC	Automotive Industry Development Centre
AMTS	Advanced Manufacturing Technology Strategy
ARC	Agricultural Research Council
AsgiSA	Accelerated and Shared Growth Initiative for South Africa
AVHRR	Advanced very high resolution radiometer
B-BBEE	Broad-based Black Economic Empowerment
BC	Bushveld Complex
BME	Budapest University of Technology and Economics
CBERS	China-Brazil Earth Resources Satellite
CCDI	Cape Craft and Design Institute
CCS	CO_2 capture and sequestration
CCT	Clean coal technology
CEOS	Committee on Earth Observation Satellites
CP	Cleaner Production
CRO	Contract research organisation
DAFC	Direct alcohol fuel cells
DIAL	Differential absorption lidar
DRFM	Digital radio frequency memory
DST	Department of Science and Technology
DTC	Diurnal temperature cycle
ECCM	Electronic counter-countermeasure
EODC	Earth observation data centre
EU	European Union
FabLab	Fabrication laboratory
FADM	Forças armadas de Defesa de Moçambique
FBG	Fluidised bed gasification
FMFI	First Mile, First Inch
FROG	Frequency resolved optical gating
GAAP	Generally Accepted Accounting Practice
GAP	Geographic analysis platform
GDP	Gross domestic product
GEO	Group on Earth Observation
GEO-4	Global Environmental Outlook Environment for Development
GEOSS	Global Earth Observation System of Systems
GHG	Greenhouse gas
GPS	Global positioning system
GRA	Global Research Alliance
HCD	Human capital development
HR	Human resources
ICT	Information and communications technology
IGCC	Integrated gasification combined cycle
IP	Intellectual property
IPAP	Industrial Policy Action Plan
IPCC	Intergovernmental Panel on Climate Change
IRMA	Integrated rural mobility and access
IRWA	International Water Resources Association
IT	Information technology
KPAs	Key performance areas
KPI	Key performance indicator
Lidar	Light detection and ranging
MEA	Membrane electrode assembly
MRC	Medical Research Council
MSG	Meteosat Second Generation
MSMI	Multi-sensor micro-satellite imager
MW	Mega watt