Our future through science

Annual Report 2011/12

CSIR

our future through science

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The Council for Scientific and Industrial Research (CSIR) was established on 5 October 1945. The CSIR's mandate is as stipulated in the Scientific Research Council Act (Act 46 of 1988, as amended by Act 71 of 1990), section 3: Objects of CSIR:

"The objects of the CSIR are, through directed and particularly multidisciplinary 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."

The CSIR's line department is the Department of Science and Technology

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

Samples contaminated with different heavy metals tested at CSIR laboratories.

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FROM OUR LEADERSHIP

Foreword

BY THE MINISTER OF SCIENCE AND TECHNOLOGY

It is my privilege to share some thoughts on the CSIR's Annual Report for 2011/12 with you.

The CSIR is our oldest and best-known science council. It was built in the immediate post-war period to promote the development and assimilation of new technologies. It is still, as it was in the 1950s, the biggest and best-resourced science laboratory complex in the country. It accounts for 15% of government expenditure on research and development.

In the early 1990s, the CSIR directed itself strongly towards the market as it saw government funding come under pressure. Though this was a logical and sensible thing to do under the circumstances, it meant that the CSIR drew on its existing knowledge resources without building new knowledge through basic and exploratory research. In the early 2000s the CSIR began to balance its commitment to commercial contracts with a strong commitment to technology-platform development.

This process has now been boosted with the CSIR's adoption of water sustainability, health, and safety and security as areas of integrated research and innovation. This is a new development with its emphasis on integration from research through to innovation. These three integrated research and innovation areas are in addition to the six already established research-impact fields of industry, built environment, health, natural environment, defence and security, and energy.

In these areas the CSIR is following promising lines of research and development. Let me highlight a few. Through the Titanium Centre of Competence, the CSIR has developed a novel process whereby titanium metal powder can be produced from our abundant mineral resource more efficiently and cost effectively than with existing plants. This process is currently being scaled up and a pilot plant will be built during 2012. Together with the process to produce titanium metal, the CSIR has also developed a process whereby titanium metal can be cast into complex components.

Titanium is a sought-after metal in especially the aerospace industry where aircraft and satellites need to be lighter in weight to consume

less fuel. The CSIR and Aerosud is developing a novel high speed process for manufacturing aerospace parts using direct laser sintering of titanium powder (additive manufacturing or 3D printing). This will position South Africa to produce high-value components for global aircraft manufacturers such as Airbus and expand the country's participation in the global aerospace supply chains. These efforts mean that by 2020 South Africa will have a new industry built around titanium. This translates to thousands of job opportunities and economic growth due to the new businesses that will be created – all based on the local production of titanium metal, turned into aircraft and satellite components.

South Africa is unable to cope with the growing TB epidemic. The CSIR has set out to address the lack of appropriate infrastructure for curbing drug-resistant TB infection and cross-infection, a key constraint in the effective treatment and rehabilitation of patients. The CSIR has been instrumental in supporting the design, development and construction of dedicated, long-term accommodation units for drug-resistant TB patients. In addition, the CSIR provides technical advice and training to the teams at the hospitals to ensure the successful roll-out of the new TB units.

The CSIR has found a different way of 'packaging' TB drugs using nano-encapsulation. This way, one can use smaller dosages, which make it more cost-effective and almost eliminate its side-effects such as nausea. But the drugs pack a much bigger punch since it can directly attack the infected issue and is not 'diluted' by having to attack all of the lung tissue. The result is that patients would only have to take one dosage once a week instead of the three dosages daily. They can also be cured within six weeks instead of the three to six months that is currently the case. The CSIR's nano TB drug delivery programme is currently in a pre-clinical trial phase and shows much promise of being successful.

The CSIR has much to be proud of in its past research. Here is something that many will have forgotten or might not even have known about: the CSIR played a key role in developing batteries used in cell phones. John Goodenough, an American, is widely credited with its partial discovery, but he had some assistance from the work of a group of researchers based at the CSIR. In the mid 1980s this group of CSIR researchers developed lithium-metal-oxide electrode materials with a spinel-type structure. Simply put, this development led to the discovery of what we know today as lithium ion (or li-ion) batteries. Japanese company Sony commercialised the first li-ion batteries for consumer electronics in 1991 and because of its low energy-to-weight ratio and slow loss of charge when not in use li-ion batteries revolutionised the battery market.

I congratulate the CSIR on its research and financial performance during 2011/12. It continues to make a major contribution to South African research and looks set to improve its contribution to innovation in the years to come.

Mrs Naledi Pandor

Chairman's overview

I wish to congratulate the CSIR on a splendid performance on all fronts: Excellence in research, good governance and a solid set of financials.

It remains my privilege to be part of an organisation such as the CSIR that continues to provide science, engineering and technology (SET) knowledge and expertise to address national challenges and to make SET – and the benefits derived from it – accessible to society.

As such, the Ministerial Review on the National System of Innovation (NSI) comes at a most opportune time and will provide further guidance to enhance the NSI landscape as an enabler for economic growth, socio-economic development and improved overall competitiveness. One of the recommendations welcomed in the review focuses on the need to improve and expand financial investment into research and development. Human capital and knowledge infrastructure recapitalisation to ensure greater effectiveness is cited as necessary to effect growth in research and development expenditure. The development of appropriate skills remains critical and the review calls for all NSI stakeholders to take action in the area of human capital development.

Further recommendations to strengthen an enabling NSI environment highlight the necessity for all roleplayers – be these from the private and public sectors, higher education institutions or research and technology organisations – to improve their collaboration.

In this regard, the CSIR has increased its efforts – and should add even more impetus – to ensure strong alliances with other science councils, higher education institutions and state-owned enterprises. Apart from its value add from a human resources perspective, the CSIR could greatly expand its contribution to South African society by addressing those challenges that require a truly collaborative approach, for example job creation, infrastructure development, and service delivery where the CSIR plays a direct and facilitative role.

The organisation has continued to streamline its operations to facilitate work on its research impact areas and flagship programmes. The latter is part of its Growth and Impact Strategy and aims to optimise the strengths of the CSIR in terms of its multidisciplinary capability, focusing on impact in the near-term. Communicating the work done in these areas – and achieving greater focus in communication – remains a key priority.

I am pleased with the progress made in terms of initiatives of national importance such as work undertaken at the Titanium Centre of Competence which will not only contribute to job creation but will add tremendous value to South Africa's vast resources of titanium-bearing minerals. Other examples of work contributing to achieving national outcomes include the development of novel, improved tuberculosis therapeutics and point-of-care diagnostics; and providing a technology platform that connects learners to mathematics tutors across a variety of communications channels such as the popular Mxit mobile service. The CSIR will continue, through its Growth and Impact Strategy, to develop cutting edge research and technologies aiming at industrial competitiveness and quality of life improvement.

Going forward and in addition to other priorities, the Board will actively engage with the CSIR on a value-adding technology transfer and commercialisation model. Some work has happened in this regard and will continue to effect technology transfer mechanisms that are competitive and well able to achieve maximum impact of the CSIR's work. The continual transformation at different levels of the CSIR will remain paramount and goes beyond demographic transformation to include transformation of the SET base in terms of appropriate qualifications.

The CSIR Board and Executive place a high premium on good corporate governance and risk management. The CSIR's excellent track record in these areas bears testimony to the organisation's continued commitment to responsible citizenship and its caution against complacency.

Regular and fruitful interactions with the Department of Science and Technology and its Minister are welcomed and I would like to extend my appreciation to Mrs Pandor and her department for their support. My sincere gratitude goes to my fellow Board members and the CSIR Executive for their dedication and valuable input. We have had the pleasure of welcoming new Board members and new members of the CSIR Executive during the past financial year – I trust their tenure will be fruitful.

Professor Francis Petersen

CEO's introduction

The CSIR continues to make great strides in achieving its strategic objectives, and it pleases me to announce an outstanding performance for 2011/12.

Organisational strategy

Towards the end of 2011, the CSIR introduced its Growth and Impact Strategy aimed at enhanced impact flowing from its work. This strategy arose from internal self-evaluation as well as external institutional and systemic reviews. The latter commended the CSIR on good research and good governance while noting that the organisation could benefit from sharpening its focus and consciously seeking to ensure that its work leads to measurable downstream impact on society and the economy.

The Growth and Impact Strategy is structured around research impact areas (RIAs) – which have been under development the past year – and flagship programmes. The six RIAs forming the building blocks of the Growth and Impact Strategy are: industry; built environment; health; natural environment; defence and security; and energy.

The flagship programmes are large, integrated development and innovation endeavours that are closely allied to the RIAs but 'nearer market' in the sense of being closer to desired impact. They will thus primarily seek to package existing technologies with objectives that can typically be achieved in the near-term. At any given time, there will only be a few flagships with a clear focus and well-articulated intended impact. Initial flagship programmes in water sustainability and health are already progressing apace.

These RIAs and flagships are underpinned by key CSIR science and technology strengths including materials science, bioscience, photonics, information and communications technologies, quantitative and systems modelling, diverse laboratory facilities, equipment and related infrastructure. The distinguishing feature of the CSIR in the national system of research and innovation institutions is the ability to bring these strengths and capabilities to bear in multidisciplinary mode to address high-level areas of socio-economic need.

The intended impact of our work is informed by a number of external drivers. From an international perspective, the Millennium Development Goals with their 2015 target date continue to shape agendas worldwide. From a national perspective, the CSIR can contribute

significantly to the New Growth Path, especially in the domain of infrastructure and in economic sectors such as manufacturing.

Another guiding framework is government's 12 outcomes. The CSIR is well positioned to contribute in a number of outcomes from safety, decent employment, a competitive infrastructure network and food security to sustainable human settlements, effective local government systems, well-protected environmental assets and a healthy life. The National Planning Commission's diagnostic report highlighted issues that need to be addressed in order to achieve government outcomes. In respect of these issues too, the CSIR can make a contribution.

The CSIR's science and technology strengths and multidisciplinary nature as described above perfectly position the organisation to intervene in these areas; and partnering with stakeholders from government, higher education institutions, state-owned enterprises and the private sector will be crucial to see South Africa's challenges met.

Human capital development (HCD)

HCD remains essential to organisational success, and is being achieved in line with the CSIR Human Resources strategy. The number of CSIR staff studying towards higher degrees and the pipeline of studentships and bursars were greatly in excess of the respective targets. This bodes well for the CSIR's future capacity and contributes significantly to the skills base of the country.

The size of our science, engineering and technology (SET) staff base is above target, and pleasing progress was made in the transformation of the SET base in terms of the proportions of black and female staff, which were both ahead of target.

Research productivity

The key performance indicators for research and development (R&D) outputs, publication equivalents and technology demonstrators, were substantially ahead of targets. The CSIR was very active on the technology transfer front; and patent and technology package targets were significantly exceeded.

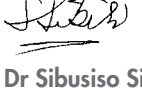
The value of contract R&D showed significant growth and once again, we ended well ahead of our budgeted figures, with the private sector and international component also exceeding expectations.

Organisational governance and citizenship

We continued to put substantial effort into organisational governance. Our record of unqualified audits is a tremendous asset and we aim to maintain this. Our safety record – although historically good – showed a marked improvement, as did our reduction in energy consumption.

I would like to thank the Minister of Science and Technology, Mrs Naledi Pandor, and her department for their support and leadership. The National System of Innovation stands on the brink of momentous changes geared to maximise the country's strengths to meet South Africa's needs. The CSIR is ready and able to support the ministry and the Department of Science and Technology in their endeavours.

My appreciation also goes to the CSIR Board, my Executive team and the CSIR staff for their dedication in helping the organisation live up to its status as a national asset.



Dr Sibusiso Sibisi

Project highlights

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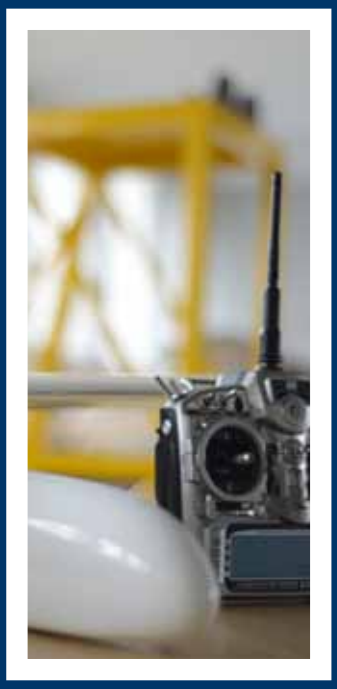
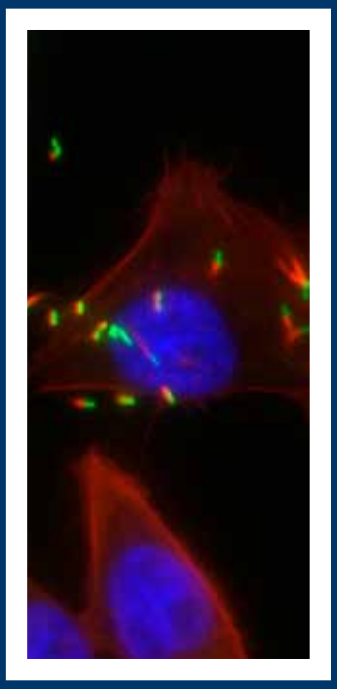
PROJECT HIGHLIGHTS

The primary role of the CSIR in responding to national priorities, is research and development to achieve innovation that will make an impact. This becomes possible through investment in a strong, multidisciplinary skills base and cutting-edge enabling technologies.

This section features a selection of directed research and development undertaken with demonstrated or intended impact in focus areas identified by the organisation (research impact areas). Also featured is work undertaken to give the country a digital advantage, with information and communications technology (ICT) as the primary enabling technology.

In other examples of our work, the benefit of science, engineering and technology for improvement in service delivery is illustrated.

Lastly, an example of the work undertaken to create enterprises with a development aim is included. In these cases, the CSIR identifies and uses solutions sourced internally and from other partners to create and develop sustainable enterprises in South Africa.

RESEARCH AND DEVELOPMENT FOR

Industry:

Advanced manufacturing and mining

02
PROJECT HIGHLIGHTS

The CSIR is developing a mine safety inspection robot for use in deep mines to inspect the mining stopes after blasting. This robot will generate a risk map of the ceiling area, highlighting dangerous areas. At the same time the mining area is mapped in 3D. As the environment consists of loose rocks of various sizes in a usually very muddy environment, traction is a significant problem. Various propulsion methods were investigated, with the carbon-fibre leg (shown here) being but one such method. This 'legged' motion is loosely based on the way a cockroach in nature is able to move over rough terrain.

The manufacturing sector is central to the economic well-being of South Africa. For the country to remain internationally competitive, it must master advanced manufacturing approaches such as additive manufacturing, biomanufacturing, micromanufacturing and nanomanufacturing. Robotics and mechatronics, logistics and supply-chain management, composite materials and laser technology are examples of CSIR competences that already make a contribution to improving the competitiveness of the manufacturing sector. The CSIR will increasingly direct these capabilities at seven sectors: Metals processing, automotives, aerospace, electronics, chemicals, pharmaceuticals and agro-processing.

South African mining also faces challenges, as all mining must be conducted more cost effectively. Mines need to be safer – accidents must be reduced and the mining environment must be healthier. By drawing on competences such as engineering, robotics and mechatronics, photonics, information and communications technology as well as logistics, the CSIR can contribute to improved mining while causing zero harm.

TITANIUM CENTRE OF COMPETENCE HELPS PUT BUILDING BLOCKS IN PLACE FOR LOCAL INDUSTRY

Samples of parts manufactured from titanium powder through two different manufacturing methods, namely powder metallurgy and investment casting. Also shown is the wax part from which a cast will be made for the investment casting process.

Cups in which titanium had been melted in a vacuum furnace during the investment casting process are featured above. Pictured top right is a sample of the titanium powder produced using the CSIR's process.

The opportunity

Establishing a vibrant new industry sector

Over the past decade, there has been a growing realisation in South Africa that the country has an industrial opportunity to add more value to its vast resources of titanium-bearing minerals. South Africa is the world's second largest producer of raw titanium minerals after Australia, yet the country has a very limited market position in the production of titanium dioxide pigment and no position downstream in the value chain for the production of primary titanium metal, mill products or finished components.

Cost-effective methods for producing titanium metal and its alloys, followed by their conversion into net and near-net products, offer the potential of a vibrant new South African industry sector.

Research and development

Perfecting titanium technology building blocks

To date, no organisation in the world has been able to produce titanium powder directly in a continuous manner on a commercial scale from titanium tetrachloride ($TiCl_4$ – the usual precursor used for titanium metal production). The CSIR is developing a process that can do just this, and is building a pilot plant for scaling up the technology. Having a large-scale, low-cost titanium metal plant in South Africa represents the basic platform on which several other building blocks in the beneficiation of titanium resources can be built.

One such building block is powder metallurgy which offers manufacturing techniques that are cost-effective and hold a huge advantage in material savings. Using these methods, the low-cost, locally produced titanium, its alloys and composites can be converted into finished and semi-finished products. CSIR researchers are perfecting these processes specifically with the creation of a titanium industry in mind.

IN BRIEF

The CSIR and several collaborators, under the umbrella of the Department of Science and Technology-funded Titanium Centre of Competence (TiCoC), are developing a range of technologies that will act as building blocks towards the establishment of a viable titanium industry in South Africa. These technologies include the piloting of a titanium metal production process (turning the mineral into titanium metal powder); turning the titanium powder into metal products using manufacturing techniques such as powder metallurgy and additive manufacturing; and the investment casting of titanium. Further downstream technology development activities in this field include new hybrid materials (using titanium) for the aerospace and defence industries.

CSIR researchers, in close collaboration with industry partner Aerosud, are developing unique laser-enabled additive manufacturing systems that will place South Africa at the forefront of this technology. It will be used for the production of unique, finished goods for the aerospace, defence, automotive and medical industries. Current research and development focuses on cutting-edge technologies such as laser metal deposition additive manufacturing (laser-engineered net-shaping); high-speed, large-area, selective laser melting; and ultra-high-speed laser-additive manufacturing.

A further building block in establishing a titanium industry is the investment casting of titanium. CSIR researchers are developing their own cost-effective process and plan to run the process commercially by 2015. With this, process parts with intricate shapes and thin walls need only limited machining after casting. The development work not only involves perfecting the casting process, but also a market evaluation, the technology's industrialisation, a plan for human resources requirements and training, and a business plan for commercialisation.

Research and development activities contributing towards a downstream manufacturing industry include the development of a strong, new, light-weight hybrid material, made up of alternating layers of carbon fibre and titanium.

Output

A sound knowledge base en route to an operational pilot plant

Since 2008, in total, 56 peer-reviewed articles within the sphere of TiCoC have been published and four patents have been filed. Three technology demonstrators have been developed with a further two aimed at completion during 2012, and three technology packages ready for transfer to industry have been delivered. At a local titanium technology transfer seminar, 18 papers were presented.

A titanium production pilot plant is being built that is set to continuously deliver 2 kg of titanium powder per hour.

The outcome

The building blocks for a fledgling industry by 2020

Since the establishment of the Advanced Metals Initiative six years ago, significant progress has been made with the development of technology building blocks for the future South African titanium industry. The South African government is showing serious commitment to realise its vision of a local titanium industry by 2020 and several challenges have already been met by the CSIR and its countrywide collaborating research institutions, universities, science councils and private companies. These challenges include developing a protective face coat – the first layer of the investment mould that reduces the reaction between the titanium and the mould material during the casting process – and developing a titanium production process that can continuously produce titanium powder from $TiCl_4$ without forming lumps that block the reactor inlets and outlets.

Major aerospace companies have indicated that they are paying close attention to the success of the additive manufacturing 'Aeroswift' project, with 2016 targeted for a fully operational system capable of producing its first parts.

To assist with the commercialisation of the project, a task team has been established with representation from the CSIR, the Department of Science and Technology, the Department of Trade and Industry, a potential financing partner, as well as a potential commercial operating partner.

New software for aerodynamic structures set to reduce the cost of developing UAVs

A computer-generated model of an unmanned aerial vehicle developed by the CSIR.

In an effort to reduce the development costs of unmanned aerial vehicles (UAVs), CSIR researchers are developing a software platform that could reduce the number of design iterations required for aerodynamic structures. The initial focus is on developing a UAV wing of which the material stiffness is tailored to perform at its best according to the environment.

The project, supported by the Aerospace Industry Support Initiative (AISI), aims to develop a methodology for the structural design of wings based on the stiffness (deflection and rotation) requirements obtained during the optimal aerodynamic design and its application. The CSIR hosts the AISI, a government-funded initiative to support the local aerospace industry.

The required stiffness characteristics of a UAV wing can be fed into the CSIR-designed software platform, resulting in less design iterations before the wing is physically built.

UAVs are increasingly being used in commercial and civilian applications, creating a new market (from its original military use) with new opportunities and new design specifications.

The CSIR's software platform will also be used to design other aerodynamic structures like wind turbine blades. With efforts underway to establish a large-scale wind energy industry in South Africa, significant investments will be made in the design, testing and manufacturing of wind turbine blades suitable for the southern African region.

Biocomposites Centre of Competence to unlock industry potential

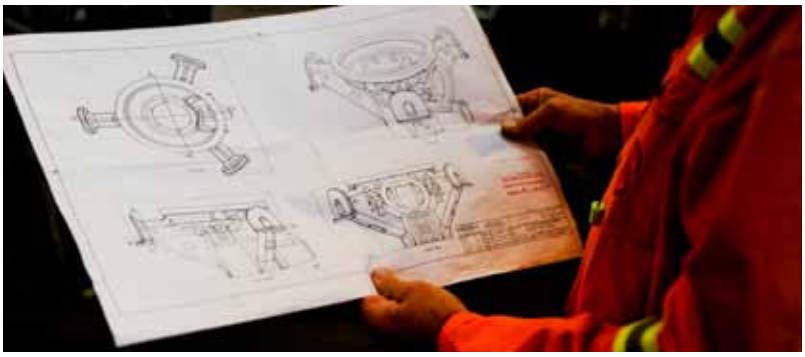
A Biocomposites Centre of Competence was created with core funding by the Department of Science and Technology (DST), and co-investment from the CSIR, as a catalyst to unlock the potential of this industry. The potential size of a fully developed biocomposites industry in South Africa is estimated at R300 to R350 million per annum for rural fibre production, and R2 to R2.5 billion per annum for final (manufactured) products.

Currently, South Africa's biocomposites industry, from primary production across the value chain to final products, including research and development activities, is very fragmented and largely nascent. It is the role of the Biocomposites Centre of Competence to pull all of the activities together in an effort to establish and build a viable and lively industry. The centre's initial focus is on the development of appropriate product technology platforms for construction, packaging, automotive, aerospace and general moulded products and human capital development to support the industry.

The CSIR and the Department of Trade and Industry have made significant investment into fibres and biocomposites research and infrastructure at its Port Elizabeth campus. Along with this, the DST has invested approximately R10.8 million in new equipment to complement this research. An example of the current research being undertaken is the development of natural fibre-based panels for aerospace applications using environmentally benign, flame-retardant treatment. Research in the development of product technologies for the built environment has resulted in initial natural fibre-reinforced prototypes of insulation panels and insulated roof panels.

A sample of a ceiling panel made from biocomposites undergoing strength tests at the CSIR's facilities in Port Elizabeth.

Technology Assistance Package programme has lasting impact on foundries



Foundries received assistance on interventions ranging from process simulation and modelling, the installation of shot monitoring systems on high-pressure die-casting machines and the development of sand foundry component-costing software, to developing a simple melt quality tester for aluminium.

Several South African foundries reported improved process efficiency and productivity following their participation in the Technology Assistance Package (TAP) programme of the Department of Science and Technology (DST). The CSIR was closely involved in the implementation of the programme.

The TAP programme was devised to assist local foundry companies to participate in Eskom and Transnet's competitive supplier development programmes. These two state-owned enterprises have embarked on extensive multi-billion rand infrastructure expansion programmes for which they will need to procure goods and services. Generally, it would have been difficult for the smaller local foundries to compete with larger suppliers from abroad. Thanks to the intervention of the CSIR-executed TAP programme, however, many of them are now confident that they have a chance to compete for tenders offered by Eskom, Transnet and any other buyer of their manufactured goods.

The TAP programme took place in two phases. For the first phase, a team of experts at the CSIR, DST, the National Foundry Technology Network and Mintek visited the foundries to identify specific technology needs. The second phase involved the implementation of technology solutions for the needs identified.

Among others, these solutions included process simulation and modelling; casting; the installation of shot monitoring systems on high-pressure die-casting machines; developing sand foundry component-costing software; developing a simple melt composition tester for the aluminium foundries; and fine-tuning a CSIR-developed integrated production monitoring system (SmartFactory) to suit their needs. The exercise spanned 18 months.

A thermal image taken at one of the participating foundries showing areas of heat loss on an aluminium casting furnace.

Electronic sounding device for mines commercialised

A miner wearing the CSIR safety device used in the detection of loose rocks overhead.

A device invented by the CSIR and used in the detection of loose, overhead rocks in underground mines has been licensed to a commercial partner.

An electronic sounding device is a sensor that mimics the performance of an experienced miner in determining whether loose rocks are present in the roof of the excavation during the entry inspection. With rock falls responsible for more than 30% of fatalities in South African gold and platinum mines, the entry inspection that occurs before workers enter a newly blasted workplace is one of the most important and dangerous tasks in underground mining operations.

The current process used in ensuring that there are no dangerously loose overhead rocks following blasting underground, includes tapping the roof of the excavation with a pry bar. A hollow sound is an indication of a loose rock. This sounding process is an acquired and somewhat subjective skill. The quality of sounding is related to the physical state of the miner undertaking the sounding. Fatigue, noise-induced hearing loss and illness often affect the competence of individuals, even within a single shift. The electronic sounding device improves the sounding process by eliminating common human errors that could lead to injuries or loss of life.

The CSIR has finalised a licence agreement with Draxin Technology to commercialise the device.

CSIR laser technology makes its way into the Carl Zeiss range of optics

Carl Zeiss South Africa has signed a one-year licensing agreement that will see the company integrating laser technology designed and developed by the CSIR into its range of optical products.

The company's products find application in a range of industries, including the military, medical, telecommunications and entertainment industries. In this case, the technology will be used in next-generation laser rangefinders and laser designators, used in missile guidance.

The technology makes it possible for almost any laser to operate in 'high-brightness' mode: A laser beam that combines good beam quality and high energy – traditionally qualities that are mutually exclusive. The breakthrough followed several years of research into shaping light.

Laser partnership: From left, Mr Kobus Viljoen, managing director of Carl Zeiss, Prof Andrew Forbes, CSIR chief scientist, Mr Dawie Mulder, project manager at Carl Zeiss and Dr Ndumiso Cingo, CSIR National Laser Centre manager, at the signing of the agreement.

South African mines used as test beds to help understand earthquakes

Japanese seismologist and scientific advisor, Hiroshi Ogasawara, and CSIR technician, Jonas Machake, checking data 3 km underground at the Gold Fields Kloof Driefontein Complex.

CSIR electrical engineer, Josias Nonyana, installs a connector to wires from a data logger, which connects to a geophone – an instrument used to measure seismic velocity. All collected data from the geophones are aggregated on the data logger. The data logger sends data to a server at the surface.

Members of the Japan-South Africa team underground at the Gold Fields Kloof Driefontein Complex.

The CSIR, in partnership with Japanese seismologists, is undertaking what is believed to be the most ambitious mine seismology project ever. Using South Africa's deep mines as test laboratories, CSIR scientists and their Japanese counterparts are trying to understand the physics of earthquakes in a bid to build technology solutions that can mitigate the risks posed by earthquakes and mining-induced seismic events, and possibly even devise methods to predict their occurrence.

Mining-induced seismic events can trigger rockbursts. Rockbursts are hazardous to mine workers in South Africa's deep mines and pose a major risk to deep-level gold and platinum mining in the country. Natural earthquakes in turn pose a serious hazard in Japan and other regions of the world that are close to plate boundaries. Knowledge gained on the working of seismic events will contribute to efforts to design and build deep-level mines and surface structures that are able to withstand large-scale seismic events.

Officially launched in August 2010, the five-year project is funded by the Japan International Cooperation Agency and the Japan Science and Technology Agency. Approximately 70 boreholes totalling 2.3 km in length have been drilled at project sites at Ezulwini, Moab-Khotsong and Driefontein gold mines. More holes will be drilled in order to imbed more sensors. Other sensors will be installed in mining excavations. In addition, a 10-station seismograph network has been established at surface-level in the Carltonville area.

Increased competitiveness through greener production

The National Cleaner Production Centre of South Africa (NCPC-SA) completed 151 cleaner production assessments at 44 plant sites during the year, resulting in the identification of cost saving options to the value of R60.1 million in the areas of water, energy and raw materials. The centre utilises resource efficiency and cleaner production to introduce more efficient technologies and enabling solutions along the value chain.

The in-plant assessments at participating companies spanned eight strategic industry sectors identified in government's Industrial Policy Action Plan (IPAP), which aims to improve market competitiveness, economic growth and job creation. These are agro-processing; clothing, textiles, footwear and leather; chemicals, plastics fabrication, cosmetics and pharmaceuticals; metals fabrication, capital goods and transport equipment; automotives; pulp and paper; tourism and hospitality; and green industries, including waste recycling/ remanufacturing. In addition to the financial, environmental and technical benefits experienced by participating companies, a more consistent product output quality was also achieved, while in most cases the working environment in participating plants improved substantially.

The services of the NCPC-SA are subsidised at this stage, and made available to participating companies at little or no cost to enable industry to proactively comply with environmental policies, as well as regulatory frameworks and standards before these are enforced.

The NCPC-SA is a key industrial sustainability programme of the Department of Trade and Industry (**the dti**) and is hosted by the CSIR.

Improving energy efficiency

During 2011, 30 companies in five IPAP sectors, including small medium enterprises, recorded energy savings of 96.6 million kWh, amounting to R74.2 million in total. This was achieved mostly through low or no-cost interventions, with a maximum payback period of three years. The interventions flowed from the companies' participation in the industrial energy-efficiency improvement project that was introduced in 2010 to contribute to the sustainable transformation of energy-usage practices in South African industry.

*Implemented by NCPC-SA (hosted at the CSIR) and UNIDO, the project is a collaborative initiative between **the dti**, the Department of Energy, the Swiss Secretariat for Economic Affairs and the United Kingdom Department for International Development.*

RESEARCH AND DEVELOPMENT FOR THE

Natural environment

02
PROJECT HIGHLIGHTS

The natural environment includes both 'wild nature' and the agricultural and settled landscapes in which we live and on which we depend. The CSIR focuses on the optimal, sustainable use of South Africa's natural resources to support development, the reduction of negative impacts on the environment, the remediation of past impacts and improved decision-making in relation to future issues, risks and options. Specific areas of CSIR research include adaptation to and mitigation of global change; management of ecosystem services for maximum long-term societal benefit; securing water quality and quantity; and providing integrated sustainability solutions for the growth and development challenges in South Africa. Various multidisciplinary competences – including environmental sciences, resource economics, hydrosciences, computational modelling, remote sensing, geospatial analysis, sensor science and statistical analysis – make the CSIR a leading contributor of solutions to the complex, large-scale and long-term issues in this domain.

CSIR researchers and partners are working with the Cape Point Global Atmospheric Watch (GAW) station, managed by the South African Weather Service (SAWS), to combine long-term observations with a country-wide network of instruments. Including observations from the SA Agulhas II, this will be the first time that data from the ocean, atmosphere and land will be combined to create a much clearer picture of how regional and urban carbon is changing both as a result of policy-driven emissions reduction and changes in the natural carbon cycle. Pictured are SAWS senior researchers Casper Labuschagne (left) and Bhawoodien Parker, checking optical sensors on the GAW instrument deck at Cape Point.

Read more about the CSIR's work on carbon flux on page 32.

PROJECTED REGIONAL CLIMATE FUTURES FOR SOUTHERN AFRICA

Above: Hosted by the CSIR, the Applied Centre for Climate and Earth Systems Science (ACCESS) is a R20 million per year initiative of the Department of Science and Technology and the National Research Foundation. With funding from ACCESS, around 100 postgraduate students enrolled at nine different universities in 2011, with research focused on a range of projects within the Earth systems science theme.

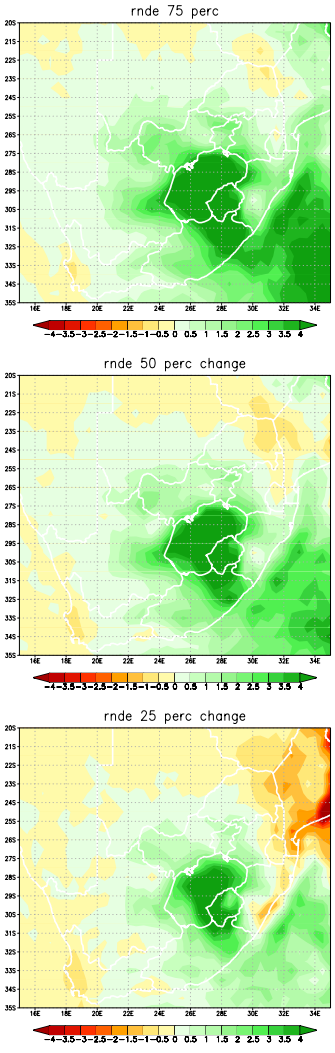


Figure 1: *Although southern Africa is projected to become generally drier under conditions of enhanced human-induced forcing, extreme rainfall events (defined as more than 20 mm of rainfall over an area of 50km² within 24 hours) are projected to increase over the central and eastern interior of South Africa.*

The different percentiles ***(Figures 1 and 2)*** *describe the range of uncertainty associated with the projections.*

The challenge

Predicting climate at regional and local scales

Global circulation models have become the main tools for the simulation of future climate change and their projections are being used extensively in the assessment reports of the Intergovernmental Panel on Climate Change (IPCC) – the global scientific body that regularly assesses and reports on the scientific developments around climate change.

However, the projections of these global models are not of sufficient spatial detail to find direct application in climate change impact studies and policy decisions. This is because, even on the fastest super-computers in the world, computational restrictions limit the spatial resolution of these models to about 100 to 300 km in the horizontal.

These resolutions are too coarse for the simulations to accurately represent the circulation patterns and physical processes that determine climate at regional (e.g. southern Africa and smaller) and, particularly, local scales (e.g. the Waterberg area and smaller).

Furthermore, uncertainty associated with projections of future climate change over Africa is enhanced by a limited understanding of the regional circulation dynamics, as well as by how regional climate systems will respond to large-scale forcings.

Regional climate models provide a computational feasible alternative to global circulation models. Based on the same laws of physics as the global models, regional models may be applied over selected areas of interest at high spatial resolution.

The research

Detailed climate projections for southern Africa

In 2011, atmospheric modellers at the CSIR took six global models that contributed to the last assessment report of the

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To better understand and describe the future impact of climate change on the southern African region, atmospheric modellers at the CSIR have performed the largest regional climate projection experiment performed to date on the African continent. The results are being used by decision-makers in the region to inform management and policy decisions when it comes to adapting to, or mitigating, the future impacts of climate change.

These and other projections indicate that the global community's ideal to stabilise global warming at 2°C will not provide a solution to southern Africa's climate change problems. Even if the world achieves this target – and currently that seems unlikely – large parts of southern Africa are likely to warm up at about twice the global rate of temperature increase.

IPCC, and for the first time downscaled these over southern African using a regional climate model.

Downscaling is the term used to describe the process through which the projections of change from global models are translated to the regional and local scales. The downscaled scenarios at a finer spatial scale are more useful for assessing local and regional impacts, adaptation and developing policies.

With support from the Centre for High Performance Computing in Cape Town, the modellers performed six simulations for the period 1961-2100, at a resolution of about 50 km over southern and tropical Africa.

These simulations, together with those being produced at the Climate Systems Analysis Group (CSAG) at the University of Cape Town, represent the largest ensemble of regional climate projections currently available over the African continent.

What are the key climate change risks for southern Africa?

Of particular concern is that temperatures over the interior regions of subtropical southern Africa are projected to rise at about twice the global rate of temperature increase, in accordance with observed temperature trends over the region.

These rapid rises in temperature over southern Africa may be expected to have impact across a wide range of sectors, including agriculture, forestry, water resources, biodiversity and human health (see **Figures 1** and **2**).

The outcome

Uptake in the SADC climate change strategy and contributions to a new global circulation model

The research results form the basis of projections in the background paper to the South African Development Community's Climate Change Strategy, currently in draft format, and will feed into the next assessment report (5) of the IPCC.

Climate modellers at the CSIR and CSAG are currently taking part in the Coordinated Regional Downscaling Experiment (CORDEX), a collaborative effort from modelling groups across the world aimed at producing large sets of high-resolution projections of future climate change over Africa and other parts of the globe.

The output of the new generation of global circulation models contributing to the next assessment report of the IPCC are to be downscaled as part of this effort.

In a related development, the CSIR has embarked on the configuration of a new global circulation model in collaboration with researchers of the Commonwealth Scientific and Industrial Research Organisation and the Japanese Agency for Marine Earth Science and Technology.

An important aim of this effort is to develop a model focusing on the improved simulation of the Southern Hemisphere and African climate systems, with the flexibility to simulate regional climate features in great detail.

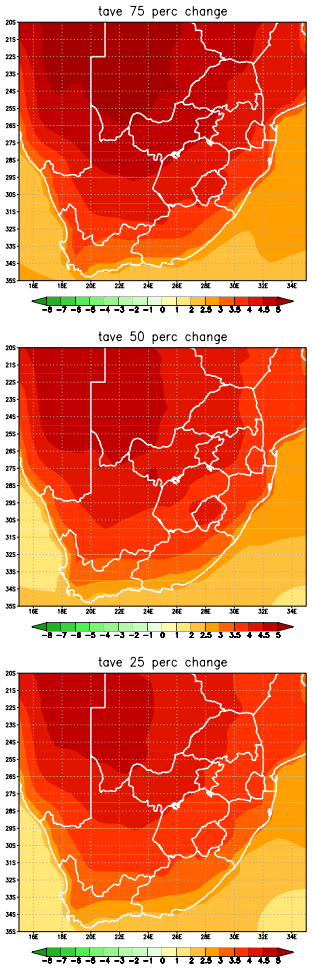


Figure 2: *Average temperature increases of more than 4°C are projected over southern Africa for 2071-2100, relative to 1961-1990. The largest warming is projected to occur over the interior. Smaller temperature increases are projected along the coastal areas, due to the moderating effects of the ocean.*

HELPING BUSINESS RESPOND TO RISK IN A CHANGING WORLD

CSIR coastal engineers used a coastal hazard risk model to develop a spatial assessment that combined a broad set of drivers of sea-storm risk along the Mossel Bay to Glentana coast. The following drivers were considered and integrated into an overall 'vulnerability score' for the coastline: elevation, distance to infrastructure, tidal range, maximum offshore wave height, degree of wave protection, historic erosion, geology, geomorphology, ground cover, human actions and relative height of the protective foredune buffer.

The challenge

Understanding the linkages of the systems in which business operates

Failure to understand the linkages between the bio-physical Earth systems and the ecological, socio-economic and external governance systems within which business operates, can spell disaster for even the most robust business.

The global insurance sector is facing unprecedented claims due to an increase in 'natural catastrophes' associated with global change. This has significant impacts on the affordability and availability of insurance, potentially slowing growth in the industry and transferring more of the burden to governments and individuals.

In South Africa, researchers found similar trends when it came to the short-term insurance sector. In certain areas, an estimated 75% of 'special peril' claims over the past 15 years were paid out in the last five years to cover climate-related events such as floods, wind and storm surge damage. In some instances, a single district municipality accounted for over 50% of these private and public claims.

Another sector that has been at the forefront of grappling with the impacts of changing Earth systems is the food and beverage industry. One of the largest global companies in this sector, South African Breweries (SAB), found that more than 95% of its water footprint lay in the growth of crops like hops and barley in the drought-stricken Southern Cape region.

The research

From the modelling of climate change projections to formulating risk mitigation

A multidisciplinary group of CSIR researchers and their collaborators have been working with two major South African corporations – Santam and South African Breweries – to help them gain a systematic understanding of how global change impacts on their risk profile.

IN BRIEF

Global change can significantly compromise the economic performance of business by heightening the consequences and unpredictability of risks. The CSIR and collaborators used innovative thinking about the inter-relationship between business and the social-ecological environment in which it finds itself, to better understand the risks involved. This understanding is used to more effectively inform management actions that are intended to build resilience of the systems on which the business depends, and help the business mitigate and withstand risks associated with unpredictable global change.

With Santam, the CSIR developed a 'proof of concept' to understand the impact of these challenges on the insurance industry. With a clear understanding, insurance companies can improve their risk assessment capability, and proactively manage the risk profile by, for example, working with key stakeholders such as local government and communities to manage degraded coastal areas.

To understand the likely effect of global change, the project team modelled climate change projections for the Southern Cape and the social-ecological risk landscape. This included risk factors such as flooding, wildfires and coastal storm surges, as well as the drivers of these risks, coupled with related ecological and social vulnerabilities. Based on these, they compiled different scenarios of change, and identified those interventions that can mitigate future risk.

Researchers found that by better understanding the social-ecological landscape within which it operates, the insurance industry can play an influential role to ensure that regulations are followed, and that the costs and benefits of different land management options are correctly considered in land-use planning and decision-making processes.

Furthermore, the project showed that risks can be managed by investing in ecological infrastructure such as restoring wetlands and coastal foredunes. Such projects reduce risk profiles and at the same time create green jobs through restoration activities funded by poverty-relief programmes.

Working with SAB to understand the dynamics of the water risk in the hops-growing region of George, the CSIR and the World Wide Fund for Nature identified three ultimate drivers of water risk: climate change, water-intensive alien trees, and competition for water from urban development.

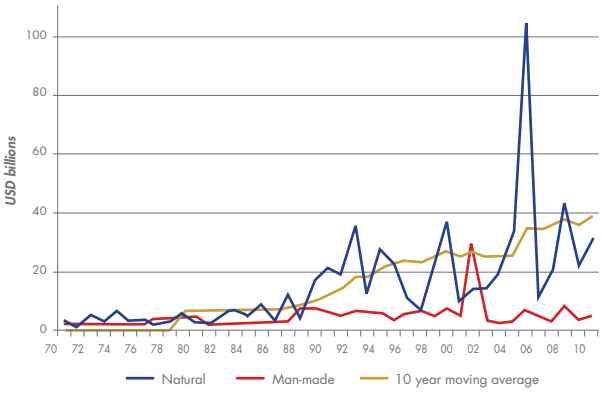
By means of a scenario-of-change exercise based on these drivers, they determined two core response strategies which should mitigate the majority of future water risk to SAB's hop farm operations. Researchers found, for example, that the rehabilitation of the hydrological and ecological functionality of the catchments will yield water and economic benefits that far outweigh future threats from climate change.

Similarly, future threats from competition for water in this region are likely to be greatly reduced through SAB Hop Farms taking a leadership role in the development of a groundwater monitoring framework and institutional structures that are able to engage effectively with decision-making processes from an informed and science-based position.

The outcome

Recognition as a climate change leader

In one outcome that indicates the significance of the work, Santam was named the winner in the Climate Change Leadership Award in the financial category for this project. The science-business collaboration aspect of this project was noted as 'the key differentiator' between Santam and the other entries.



International trends in insured claims due to natural catastrophes and man-made disasters from 1970 to 2010 (Carpenter 2010).

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Developing sustainable land-use options for mined sand dunes

In a unique partnership with Richards Bay Minerals (RBM), a Rio Tinto company, CSIR sustainability experts and tree geneticists have pooled their expertise to develop sustainable land-use options for a typical mined sand dune area in northern Zululand, KwaZulu-Natal.

RBM has been mining the coastal sand dunes in this area for valuable minerals such as ilmenite and rutile for the past 35 years. In line with Rio Tinto's biodiversity strategy, the company initiated a unique rehabilitation programme in which it maintains the ecological processes that drive the restoration of indigenous dune forest on a third of its mining lease area. However, this is the first time in South Africa that mined dunes are being considered for large-scale commercial agricultural production.

Starting five years ago, CSIR researchers assessed various types of forestry trees, herbs, vegetables and legumes to determine which types would best survive the harsh coastal conditions typical of the area – high humidity, strong winds and poor soil – and also be sustainable and commercially viable. The different plants were also assessed in terms of their contribution to soil rehabilitation by means of, for example, nitrogen fixing.

For the forestry trials alone, tree breeders experimented with 700 different genotypes of *Eucalyptus* and pine, and planted nearly 2 800 saplings. Over the past two years, the crop trials delivered good quality essential oils from rosemary, rose geranium and tea tree. Researchers are now working on an economic feasibility study for the large-scale production of these essential oils.

The long-term objective of this rehabilitation project is to present the community with a 'basket' of economic opportunities when the mined land is returned to them.

Helping small-scale rooibos farmers to adapt to climate change

Dr Alex Valentine, left, from the University of Stellenbosch, and local rooibos farmer, Petrus Ockhuis, measuring gas exchange needed for photosynthesis with an infrared gas analyser.

Researchers are investigating the implications of climate change for rooibos *(Aspalathus linearis)* cultivation by small scale farmers as a livelihood strategy in the semi-arid Cederberg region, South Africa.

Funded by the Volkswagen Foundation, the CSIR is part of an international team working towards the development of adaptive management strategies for small-scale farmers in semi-arid South Africa and Ethiopia under changing climatic and policy conditions. The investigation into rooibos cultivation is one of the key components of the project. The other partners are Indigo Development and Change, the University of Cape Town, Stellenbosch University, the Environmental Monitoring Group, the University of Hamburg and Hawassa University.

Being a rain-fed crop, rooibos is strongly influenced by the climate, especially through fluctuations in precipitation and the occurrence of extreme events such as consecutive days of high temperature, which may significantly stress plants.

The predicted increase in temperatures and altered rainfall patterns for the greater Cederberg region may modify crop performance and existing spatial distribution patterns and suitability of wild and commercial rooibos. Bearing in mind the extreme poverty faced by people in the area, even slight variations in temperature and precipitation may have severe implications for farming-associated activities without appropriate adaptation measures.

With the use of geographic information systems, researchers are using species distribution modelling to indicate possible shifts in the growth areas of both wild and cultivated rooibos.

Improving estimates of fruit tree water use

Modern agriculture – fruit tree orchards in particular – aims to use less water for irrigation without a decrease in fruit quality and yield, especially in water-stressed areas. Technological advances in sap flow and energy balance monitoring instrumentation now make accurate measurements of transpiration (individual tree water-use) and total evaporation (orchard water-use) possible.

In a project funded by the Water Research Commission and the Department of Agriculture, Forestry and Fisheries, CSIR researchers and partners are quantifying the actual water use of orchards through the use of modern micrometeorological instrumentation and site-specific information on climate, soils and tree physiological and phenological changes. They hope to provide useful data for on-farm water management planning, water-use modelling and regulation within the fruit tree industry by 2014 to improve irrigation scheduling and water-use efficiency.

Measurements of a range of variables have been taken in orchards over the past five years.

A national-scale strategy for managing alien invasives

Invasive Australian Acacia trees and shrubs frequently choke the country's river systems, where they impact negatively on water resources, streambank stability and biodiversity.

CSIR researchers recently made recommendations that South Africa's current national-scale strategy to clear invasive alien plants should be substantially modified if impacts are to be effectively mitigated. Since the inception of the programme in 1996, the CSIR has played a leading role in assisting government to effectively manage invasive alien plants in a holistic way.

Earlier estimates by the CSIR indicated that alien plant invasions are responsible for environmental costs amounting to an estimated R6.5 billion every year, and that these losses would have amounted to an estimated additional R41.7 billion had no control been carried out. This indicates a saving of R35.2 billion every year (approximately 4.8% of South Africa's annual GDP).

However, in 2011, researchers found that current efforts were nonetheless inadequate to stem the spread of invasive alien species, despite spending R3.2 billion on control over the past 15 years. This resulted in recommendations that South Africa's current national-scale strategy to clear invasive alien plants should be substantially modified if impacts are to be effectively mitigated. The recommendations included several changes that would improve the chances of stemming environmental losses due to invasion. They are, among others, the concentration of funding in priority areas where water resources, grazing and biodiversity are under the greatest threat; a significant increase in the proportion of funds spent on biological control; and the adoption of strategies to deal more effectively with alien plant species (such as pines, mesquite and wattles) that provide benefits but also do harm.

This realignment of South Africa's national-level strategy would ensure that the benefits of control are maximised and impacts minimised, and should be implemented at a national level. The research results have also been published in leading accredited international journals such as *Biological Conservation* and the *Journal of Environmental Management*.

Building the resilience of coasts to storms and sea level rise

CSIR coastal engineers assessed and mapped areas along the southern and south-eastern African coastline that are most vulnerable to the potential impacts of climate change. Combining coastal engineering skills with expertise in geographic information systems and numerical wave modelling, they identified environmentally friendly adaptive and cost-effective technical protection measures. Measures include management and governance options, soft engineering or restoration, and hard engineering or armouring.

The coastal zone of the south-western Indian Ocean region is particularly vulnerable to the expected impacts of climate change. Contributing factors include vast, low-lying coastal plains; high population concentrations in close proximity to the sea; and poverty. This situation is aggravated by direct exposure to high wave energy regimes in some parts. Large numbers of the local population also rely heavily on economic benefits provided by the coastal zone.

Some adaptation practices can reduce the potential impact by factor 10 to 100. This work forms part of a larger programme led by the National Institute for Disaster Management in Mozambique, and feeds into the country's National Climate Change Response Strategy.

Pictured is the highly vulnerable area at the north-western tip of the city of Pemba in Mozambique, where the village of Paquite is regularly threatened by sea inundation.

Advanced mapping technology set to improve vegetation management

CSIR researcher Nuveshen Naidoo gathers data in the study area.

Researchers have mapped and measured vegetation in the Kruger National Park area in 3D from the sky (using light detection and radar, or LiDAR) and on the ground. The data collected by the CSIR and its partners, the Carnegie Airborne Observatory, SANParks and the University of the Witwatersrand (Wits) are set to change the way such large areas can be managed.

LiDAR data from the 2008 flight campaign enabled researchers to map and measure woody biomass in rural areas such as Bushbuckridge, where harvesting of wood from trees is still the primary source of fuel for cooking and heating even when electricity is available. Combining this data with socio-economic data collected from the area by Wits, projections are that, at the current rate of fuelwood consumption, the woodland resources for some rural villages in Bushbuckridge may only last another 12 years.

Another significant finding is that large herbivores and fires may have a bigger impact on the loss of big trees in conserved areas than in communal areas, where large trees like the Marula are valued for their fruits.

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Reducing uncertainty of carbon dioxide uptake in the Southern Ocean through modelling

Using the modelling skills of mathematicians and statisticians, scientists now have a better understanding of the seasonal cycle of carbon in the Southern Ocean – which holds important clues to its sensitivity to climate change.

This changing ocean sink for CO_2 has implications for the global emissions reduction objectives being negotiated through the Conference of the Parties of the United Nations Framework Convention on Climate Change.

The project looked into the empirical relationship between the partial pressure of CO_2 and other variables in the Southern Ocean that are observable by satellite.

The methods developed through this study are essential due to the sparseness of observational CO_2 data in the Southern Ocean. The approach was to explore different non-linear statistical models that may enable remote sensing data sets to be used as proxies for missing CO_2 data.

The impact of the research lies in reducing the current uncertainty (from 50% to 10%) of the regional Southern Ocean CO_2 exchange with the atmosphere. This is needed to reliably calculate the terrestrial carbon budget and the year-on-year changes.

Three pieces of the big picture: Carbon dioxide clues from Skukuza, the Southern Ocean and Cape Town

The CSIR's capabilities in measuring the exchange of carbon dioxide – the main greenhouse gas – between the Earth and the atmosphere are unique in South Africa and make an important contribution to our understanding of global warming.

The flux tower near Skukuza in the Kruger National Park, left, is the longest-running facility of its type in Africa. It is one of only a handful world-wide in savannas. The work shows that this savanna is acting as a carbon source.

The Southern Ocean Carbon-Climate Observatory uses the voyages of the SA Agulhas to and from Antarctica and sub-Antarctic island bases to keep track of carbon exchange by the vast Southern Ocean. The work demonstrates how sensitive oceanic uptake is to changes in circulation, which are driven by climate change itself.

The regional CO_2 observatory deployed around Cape Town is testing new technologies to independently verify the magnitude of emissions of greenhouse gases from urban areas. It is the first application of these techniques outside of the developed world. The study is a prototype for a system to measure the emissions of the country as a whole.

Bioremediation for the Upper Olifants River catchment

CSIR researchers have identified four species of plants in the heavily-polluted Upper Olifants River catchment that can trap heavy metals such as aluminium, manganese and iron in their roots or shoots.

As part of an ongoing three-year project funded by the Olifants River Forum, this information will now be used for the rehabilitation and management plan for the Upper Olifants River. This will be the first river-wide bioremediation programme in South Africa, and will serve as a benchmark for the management of all catchment areas in South Africa.

The common occurrence of these reeds, rushes and sedges in the catchment make them valuable species to consider in the construction of artificial wetlands or in rehabilitative planting along riverbanks.

Useful plant species for rehabilitation need to be carefully screened for their metal uptake capacity, growth form, tolerance to pollution and natural occurrence in a catchment.

CSIR researchers Peter McMillan and Klaudia Schachtschneider at work in the Olifants River catchment.

After testing eight potential plant species, researchers identified four wetland plant species useful in remediation.

Removing heavy metal from groundwater using nanoclay-composites

CSIR researchers are investigating the potential use of clay nanocomposites as a low-cost adsorbent to remove chromium (VI) from wastewater. Chromium (VI) is a very toxic and hazardous element to living organisms and the environment. It can enter the environment through surface waters and reach groundwater through the discharge of wastewater from industries. Industries that typically produce chromium (VI) wastewater include those involved in electroplating, leather tanning, metal finishing, dyeing, fertilisers, textiles and nuclear power.

While the research is still at an early stage, CSIR researchers have so far successfully showed higher chrome uptake in the nanocomposite than when various low-cost absorbents have been used on the same sample. This was during a laboratory-scale performance assessment of the CSIR-prepared nanocomposite in the treatment of real industrial water containing chromium (VI), which was sourced from a big producer of chrome ore in Africa. The CSIR-funded research continues and researchers will now move from laboratory-based experiments to column experiments, which will determine the research's industrial applicability.

PhD student Katlego Setshedi adds clay nanocomposites to a wastewater sample polluted with chromium (VI). Once the yellow polluted water has been passed through the nanoclay composite the effluent is clear and clean, as seen in the transparent water sample.

RESEARCH AND DEVELOPMENT FOR

Defence and security

Technology has brought innumerable benefits, progress, new opportunities and hope for mankind. It has also led to new security threats and new means for countering threats. The constantly increasing pace of technology development has led to a rapidly changing battle space.

The cyber dimension is the new frontier, on par with the conventional spheres of defence on land, sea and in the air. With a deluge of new technologies, the key is to understand which tools, methods and skills to combine, and in what configuration, to mitigate security risks most effectively and efficiently.

Understanding the key role of science, engineering and technology (SET) in the bigger defence system is critical. Integrating SET with policy and strategy setting, force planning and deployment, down to optimal use of available resources, is the foundation of truly 'smart' defence.

The CSIR continues to play a pivotal role in developing a defence capability that operates at an advanced and ready level to defend the country against regional and national threats.

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The CSIR has a number of small, unmanned aerial systems (UAS) – aircrafts with no on-board pilots – including the 1.7 m-span relaxed-stability research platform, Sekwa; the 2 m-span hand-launched Indiza, now fitted with a pan-and-tilt dual camera system (pictured here); and the twin fuselage 4 m-span modular UAS that can carry a 10 kg payload. These airframes are all used to facilitate research into various topics, ranging from stability and control to structural optimisation, or as airframes for operational concept evaluation. A simulated UAS mission environment has also been created through which the command and control operational structure for unmanned aircraft missions can be evaluated.

NOVEL, REMOVABLE DAVIT SYSTEM ENABLES INTEGRATED ANTI-PIRACY OPERATIONS

The CSIR system is fully removable – and installed in minutes. It is able to carry crafts of different sizes. During the development phase and undertaking of sea trials, the SANDF needed to respond to an actual piracy threat on the east coast of Africa. With the pilot model installed, the SA Navy had its first success with the new system – despite it still being a demonstrator version.

The challenge

Added agility for rapid deployment to counter piracy

The 2012 Draft Defence Review states: "The substantial increase in acts of piracy along Africa's coastline is of grave concern as it threatens the peace, security and stability of the continent. Somali pirates have operated as far south as the Mozambique Channel and as far east as 72° east towards the Maldives. As a direct consequence of the piracy along the east coast of Africa, a growing number of shipping companies have had to route their ships via the Cape Sea Route instead of using the Suez Canal. Such dynamics – together with requests from foreign governments and multilateral organisations – have compelled South Africa to respond to such security threats. As such, defence will play a key role to help combat piracy, especially since recent incidents have occurred along the Southern African Development Community coastline."

In stepping up to this challenge, the SA Navy soon realised that its existing anti-piracy deployment capabilities needed to be extended to be larger, faster and more integrated. This came down to the fact that ships needed to carry more than just their work boats. Small boats also needed to be rapidly deployed and returned to a mother ship – while at speed.

Research and development

Tailor-making a Davit system for the task at hand

The CSIR's maritime security group already had experience in the field of controlled surface deployment of boats from moving ships. A removable Davit system (the structure used to lower objects over an edge) was one solution that was put to stringent sea trials along the Cape Peninsula, with various different boats from the Maritime Reaction Squadron, South African Special Forces as well as the SA Navy.

The system comprises a wave-compensating hydraulic Davit system mounted on a load vector-compensating base. The base

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The Cape sea route has become a preferred option for shipping companies in response to increasing incidences of piracy along the east African coastline. South Africa has had to consider effective means to combat such activities and safeguard the integrity of its maritime territory. The South African National Defence Force (SANDF) identified the need to have a larger, more agile, high-speed maritime capability, ready for rapid deployment at sea.

The CSIR developed a novel hosting system that allows for the loading of more – and different types of – vessels onto larger navy ships. These can be released and returned to the ship while cruising at speed.

also houses the hydraulic drive system with its electronic and manual controls; stored energy to move the boat between the stowage point and the water; as well as the logistic support equipment needed for the boat. The complete system fits onto a shipping container footprint mounted and adapted on the ship's deck. The Davit system can accommodate boats of various hull shapes weighing up to five tonnes. The boats as well as crew can be lowered and retrieved safely by the Davit system with the hosting ship underway. Two of these Davit systems are normally fitted to a ship, with another two boats housed in the ship's boat bay on CSIR-developed cradle systems.

The outcome

From sea trials to orders for more systems

While sea trials were underway, South Africa – through the SA Navy – was called upon to prepare for anti-piracy operations. The SA Navy requested use of the newly developed model of the removable Davit system for operational application in its combat exercise. That success led to further orders for more such systems.

Apart from successfully supporting integrated naval operations on the east coast of Africa, the CSIR-developed capability has also strengthened the SA Navy's ability to conduct extended operations up the west coast of Africa, ensuring the SANDF's mandated responsibilities within the SADC and African Union security environments.

More systems were subsequently developed for Navy frigates as well as the supply vessel, SAS Drakensberg, for integration missions on a rotation basis. This allowed the SA Navy to integrate its warship capability with various specialised elements within the SANDF to create an extended off-board capability. This capability includes visit, board, search and seizure, interdiction, insertion and recovery over beaches, as well as augmenting search and rescue capabilities.

The longer-term impact of these types of integrated capability building blocks is that these systems can also be utilised on new naval procurements, creating a highly mobile maritime capability to help counter maritime threats in and around the South African waters. The SA Navy now has an improved ability to protect South Africa's territorial integrity (including natural resources), as well as countering the economic sea-lines of communication used by multi-national crime syndicates and acts of piracy.

The development of the removable Davit system has resulted in technology packages that have attracted international attention. The system also potentially offers good business opportunities for small and medium-sized manufacturing enterprises stimulating the engineering environment for ship building and support within South Africa.

The new hosting system on large navy ships supports a more mobile and agile maritime security capability to act against security threats, protect marine assets, and safeguard the integrity of waters along the South African and broader African coasts.

NEW SOFTWARE SIMULATES COMBAT SCENARIOS FOR SUPERIOR FIGHTER-AIRCRAFT ABILITY

Photo: Frans Dely

The challenge

Testing enhancements to fighter aircraft without incurring the associated costs

Fighter aircraft are complex and high-performance systems. With rapidly changing technology capabilities constantly being added to the aircraft, squadrons need a means of testing these enhancements, trying out combat scenarios, and developing formations and tactics. Flying actual air-combat sorties is very expensive. If the real thing is impossible, science can create a virtual reality.

The CSIR's simulation system creates life-like combat scenarios that help pilots to develop their doctrine and tactics without the costs and risks of actual practice runs. It also captures the aircrafts' networking capability so that a pilot can experience broad situational awareness inside the simulated environment – including communication with partners in other planes for smarter tactical flying.

The Gripen story

Better training for better use

The SAAB Gripen fighter aircraft is a high-performance system. It carries advanced capabilities in terms of radar systems, helmet-mounted displays (HMD), networking and missile launching at targets out of sight of the missile seeker head at launch. New technologies mean development of new tactics – not only for greater performance, but also for maintaining the safety of the wingmen.

The CSIR-developed mission simulation framework software provides a simulated environment within which combat scenarios and aircraft capabilities are modelled. Loaded onto secure laptops, the SAAF can develop flight formations and tactics using the aircrafts' data links and radar capabilities, air-to-air missiles, etc. to optimise mission effectiveness.

Photo: Frans Dely

Of particular importance is the understanding of the optimal use of the aircraft's situational awareness capabilities. For example, its networking capability opens up a number of new tactical opportunities where the information on a threat detected by one aircraft's radar can be transmitted to colleagues' aircraft via the data link to provide them with an enhanced idea of what is happening around them. This capability changes the way pilots will fly the aircraft in future and was modelled early during the development of the simulation framework.

IN BRIEF

Engineers at the CSIR have developed software to create simulated combat scenarios, integrating major aircraft capabilities such as air-to-air missiles, data links, radar, etc. The South African Air Force (SAAF) is using the software for an improved understanding of the systems to design flight formations and develop tactics against new threat scenarios it may face.

Advanced multi-mode radar further adds to the capabilities of the Gripen aircraft and has been captured in the simulation software. In this way, pilots gain insight into best use of radar and a means to investigate the effect of different modes in a given combat scenario.

The software

The current second-generation simulation capability operates on a common simulation backbone to the other defence-related simulation systems developed by the CSIR for electronic warfare, ground-based air defence and joint operations. All of these utilise the same curved-earth environment with integrated command and control links.

The system allows for the modelling and evaluation of various aircraft performance models as well as various store models (including laser pods, dumb and boosted bombs and air-to-air missiles). Air-to-air missile hit-probability modelling is also incorporated. The aircraft radar is modelled in high fidelity and the option to change radar modes during the simulation has been included. Furthermore, the HMD is also modelled – combined with a visual detection model for the pilot.

Basic models of the electronic warfare system are included and validations can be carried out against the high-fidelity simulations at the CSIR.

The outcome

Uptake at SAAF training facilities

The capability of the mission simulation framework to model radar coverage in particular, first resulted in the system being actively used by the SAAF during the Soccer World Cup in 2010 to develop tactics for safe and effective air patrol by the Gripen aircraft.

The second-generation capability has been transferred onto a small number of secure laptops that have been presented to members of both 2 Squadron and 85 Combat Flying School for use in their development of tactics and doctrine.

The missile story

Better training for better hit rates

Firing a missile requires rapid decision-making with an understanding of the probabilities of success. The CSIR was tasked to incorporate a model of the Denel-developed A-Darter missile into its mission simulation framework to assist the SAAF with developing successful combat strategies. A table of hit probabilities was generated; it can be rapidly interpolated to indicate best options for a hit in any engagement scenario in the missile's envelope, regardless of all possible evasive manoeuvres by the target.

Taken up in Gripen and Hawk desktop training

The software was demonstrated to SAAF fighter pilots at both 85 Combat Flying School and at 2 Squadron. Pilots explained that internationally, many missiles launched in air combat miss due to the pilots firing the missile outside its effective envelope. From evidence, it emerged that pilots trained using the software have a better understanding of missile envelope and performed more accurately. The SAAF has requested that the system be installed for use by the pilots flying both Gripen and Hawk aircraft using the A-Darter missile.

Electronic warfare simulation system goes international

A novel sensor and electronic warfare engagement simulation product developed by the CSIR has now sprouted sister systems within the Kingdom of Saudi Arabia, as well as at several Chinese research institutes. The product was initially designed for the South African National Defence Force (SANDF).

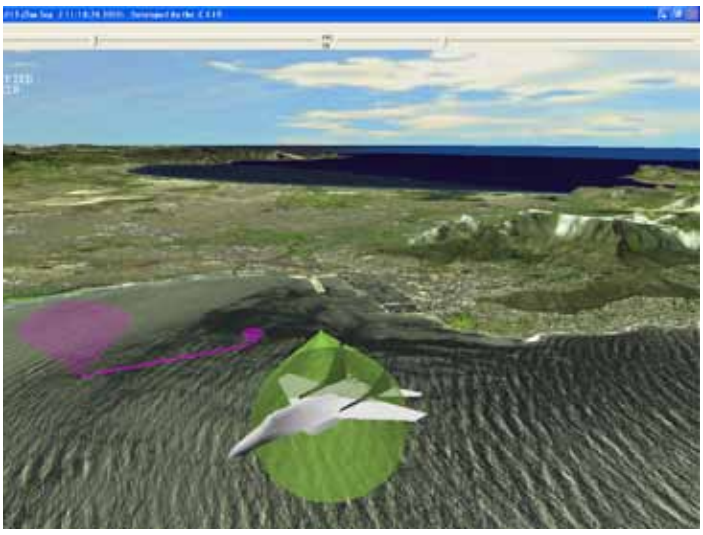
The sensors and electronic warfare engagement simulation (SEWES) comprises software on a cluster of computers and provides an architecture within which models – representations of defence systems and their subsystems – interact with each other in a simulated electronic warfare engagement.

In the case of the Saudi system, CSIR researchers worked with their Saudi counterparts to create simulation scenarios of an engagement between two platforms, each platform with a tracking radar and an airborne target.

Versions of the system used in other countries contain customisable versions of generic system models supplied by the CSIR – different from that used by the SANDF locally.

The system's uniqueness resides in its ability to provide a dynamic many-on-many electronic warfare simulation environment that can be customised and populated with various models by the end user. Naval, air or ground platforms can simultaneously be used in the simulation.

The innovative architecture allows one to easily modify the simulation to specific requirements and events to interoperate with other simulations and hardware systems. This means a fully scalable, distributed simulation can be created with varying numbers of platforms and processing units in the cluster.



SEWES is an important tool for research; training; mission planning and debriefing; tactics and doctrine development; and investigation of consequences in certain scenarios.

Solving mobility challenges for border patrol action

The CSIR has added a series of robust capabilities to commercial vehicles so that they can be used as ambulances or control vehicles in areas that are difficult to traverse and have sensitive ecosystems. The work is of great importance for South Africa's effective border patrol activities.

The South African National Defence Force (SANDF) is tasked with the responsibility of border safeguarding – a role that has a number of operational challenges requiring innovative solutions. The vehicles need to offer protection against dangerous animals and exposure to insects and extreme heat. They must be suitable for patrols, with fast-reaction capabilities and the ability to carry people, medical support and other loads. To address the mobility requirements, the CSIR was asked to assist in identifying the best-suited family of vehicles that would support effective border patrol.

A stringent process of evaluation led to the identification of a commercial vehicle family, whereafter the CSIR set about inventing enhancements to further bolster the different vehicles to safely carry troops, medical equipment and patients on stretchers, logistical as well as command and control systems. The enhancements included special roll-over protection structures – certified by the International Organization for Standardization and made from new composition steels and structural sections and interfaces to comply with load restrictions. The structure also had to be approved by the original equipment manufacturer (OEM) to ensure that normal vehicle warranties remained intact. This development was done in collaboration with the University of Pretoria and a manufacturer that was approved by the OEM – to whom the final engineering data pack was transferred.

The CSIR's work enabled the SANDF to define the special requirements of the patrolling activity and acquire the most robust, cost-effective solution for the protection of the country's borders.

Instrumentation applied to the interior of an armoured personnel carrier and its occupants during a vehicle validation test.

Technology for armoured vehicle evaluation

The CSIR conducts validation tests of armoured personnel carriers to ensure adequate protection of its occupants when exposed to threats.

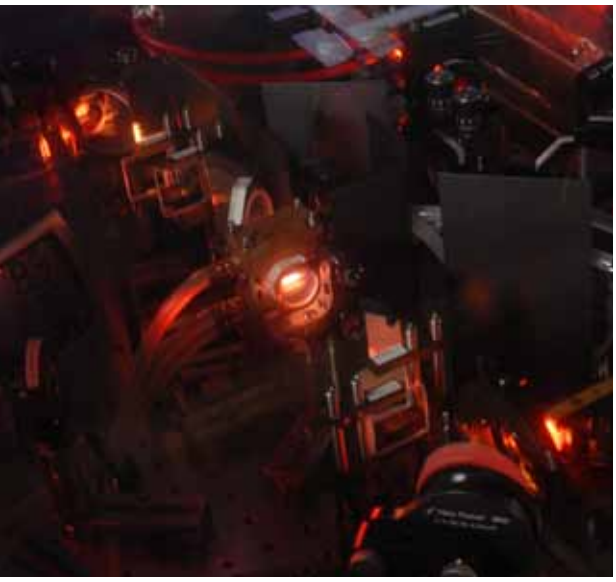
The tests are conducted at the CSIR's detonics, ballistics and electronic laboratory test range.

The occupants of the vehicle, represented in the picture, below, by the anthropomorphic test devices – better known as 'dummies' – are instrumented from head to toe with accelerometers, pressure sensors, temperature sensors, potentiometers and load cells.

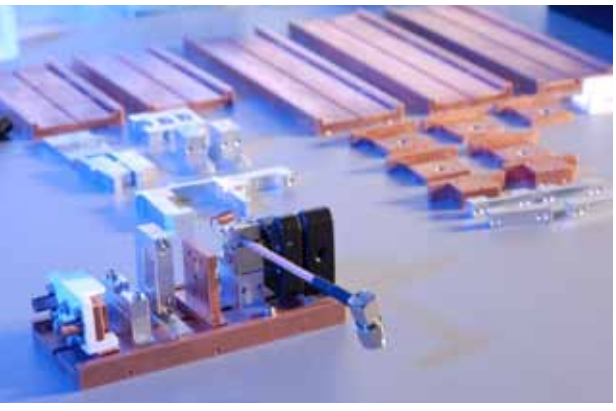
This instrumentation allows the researchers to measure factors such as data pack acceleration, overpressure, temperature, movements and loading of body parts during the blast. The carrier and its occupants are exposed to the blast from an explosive charge located directly under the hull of the vehicle or under a wheel or placed on the side of the vehicle.

Sets of lights provide visibility for the high-speed photography within the vehicle which is used to characterise the dynamics of the occupants, the structure of the vehicle and movements of any other objects within or entering the interior of the carrier during the blast.

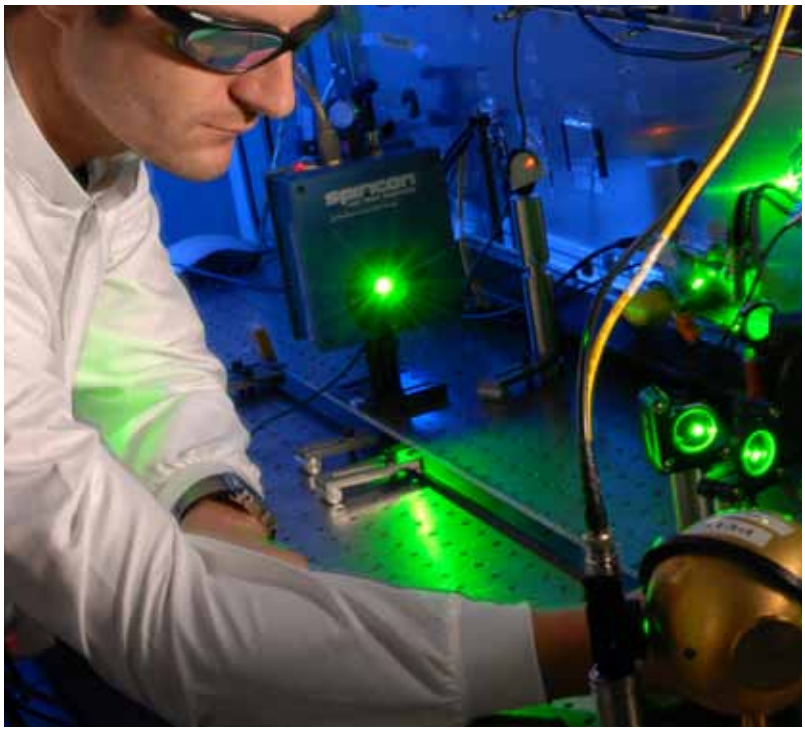
High-performance lasers on track for commercialisation



Shown above is the best performance ever recorded by a 2 µm-wavelength solid-state laser. A solid-state laser uses a gain medium that is in a solid state, rather than a liquid, such as in dye lasers or a gas, in gas lasers. Some of the results of this high-energy master oscillator power amplifier system that generated a record-breaking 330mJ, have been published in a peer-reviewed journal.



The elements of a compact laser during the pre-assembly process of a modern solid-state laser that is ready for commercialisation.



A CSIR laser scientist analyses a laser's performance.

CSIR researchers have over the past few years developed state-of-the-art laser technologies, with high-output powers and pulse energies. The technology is poised to offer unique and improved lasers that are particularly suitable for countermeasure technology in the defence industry. It is also increasingly important in civil aviation where the need to protect aircraft against man-portable air-defence systems has become a reality.

These technologies are currently being packaged into portable laser systems for numerous applications by different end users. Other applications for these lasers include materials processing, atmospheric research, range-finding and medical research and procedures. The objective is commercialisation to stimulate the emerging photonics industry in South Africa.

The CSIR research team's new technology demonstrators include a high-power 2 µm solid-state laser that incorporates the latest mirror technology for strict wavelength control, as well as a compact high-power optical parametric oscillator producing outputs in the 3 to 5 µm-wavelength range.

Better identification and characterisation through radar cross-section technology

The CSIR has developed a novel radar-based system that allows for cross-section measurements of any target in a dynamic environment. The system can be used to assess targets moving up to the speed of sound, or faster, and within a radius of up to 20 km of the system. It also provides more data than conventional radar systems, enabling detailed characterisation that aids decision-making.

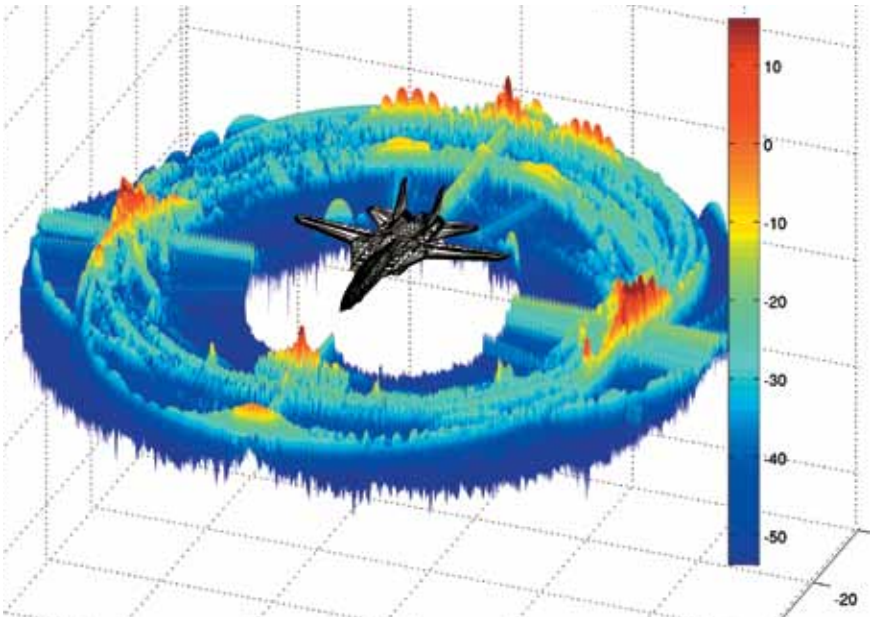
A major benefit of the new target feature measurement system is the fact that it is mobile and can be deployed almost anywhere.

The system can be used to independently verify the radar cross-section of ships and aircraft purchased by a country, as well as to develop the required operational doctrine once purchased. The system can also be used by designers of military platforms to reduce the radar signatures of the platforms they design.

The system is invaluable as a research tool to gain insight into the characteristics of targets in their environments before the development of a new radar system commences. An example of such an application is the CSIR's work on small boat detection in sea clutter, which is relevant in the protection of South Africa's abalone and other natural resources.

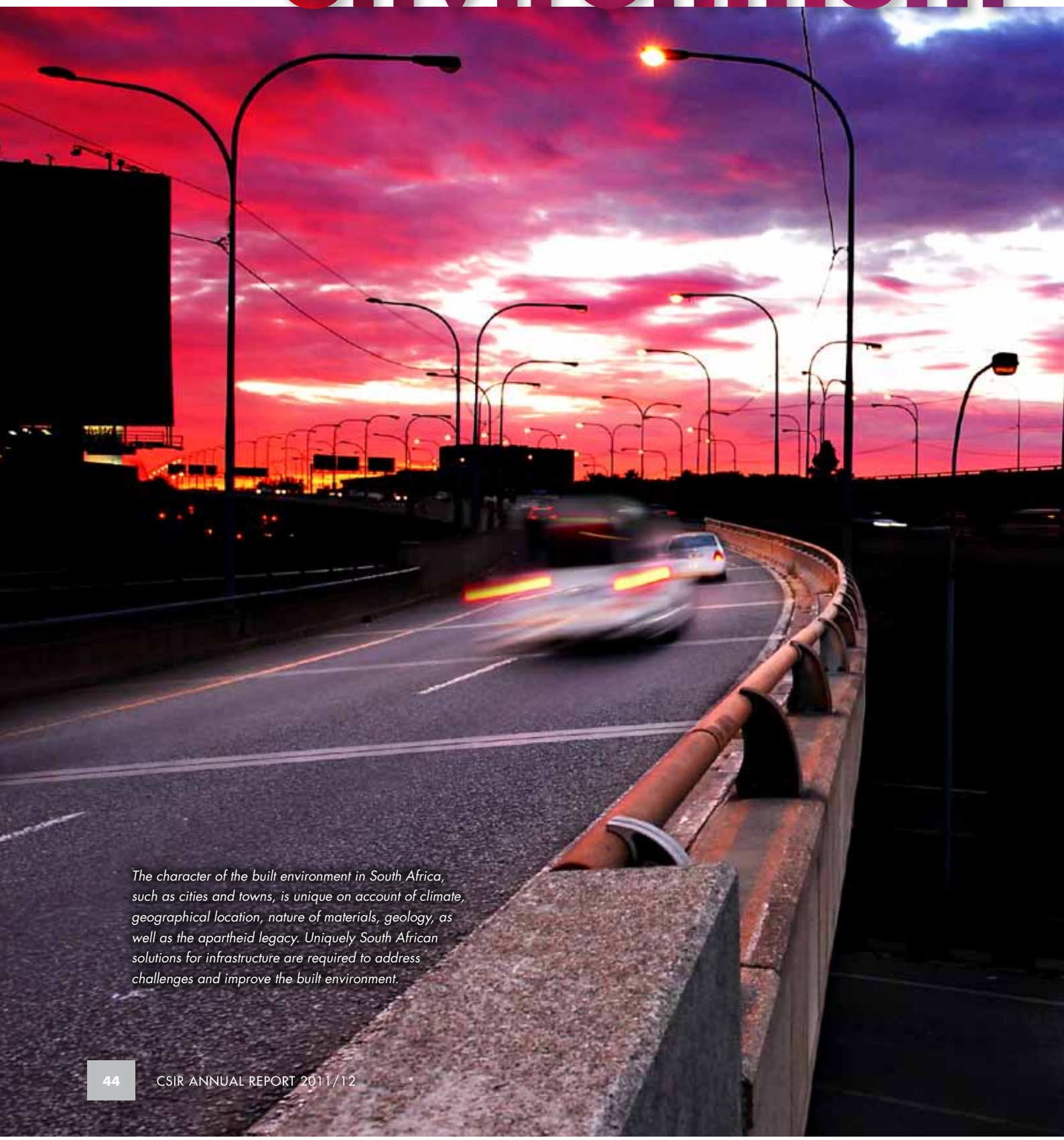
The system was first delivered to a radar research organisation in the Far East and a second contract for such a system was signed recently with a research organisation in the Middle East.

This image shows the high-range resolution profile response of a F14 fighter aircraft model. The red peaks indicate higher radar cross-section values (larger parts of the plane) as a function of the azimuth angle and range. These characteristics are used to identify the craft (what it is), and classify it (whether it is, e.g. an ammunition or person carrier), to ensure that the right countermeasures are put into action. Radar cross-section technology alone does not hold all the answers. For this reason the CSIR adds modelling and simulation technologies in processing the data to generate a fully modelled object and to arrive at an approximate view of even foreign objects not previously measured.



RESEARCH AND
DEVELOPMENT FOR THE

Built environment



The character of the built environment in South Africa, such as cities and towns, is unique on account of climate, geographical location, nature of materials, geology, as well as the apartheid legacy. Uniquely South African solutions for infrastructure are required to address challenges and improve the built environment.

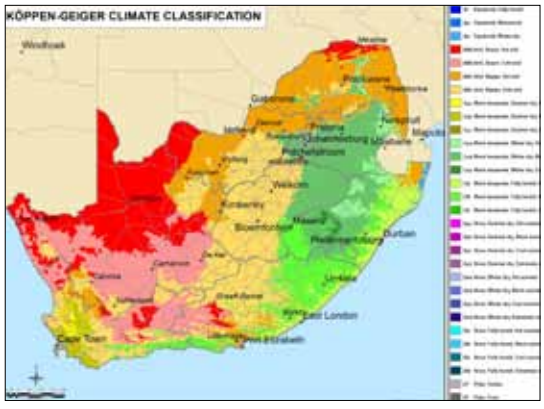
Investment into infrastructure stimulates economic growth and thus job creation. Infrastructure also has social bearing – public buildings, schools and hospitals play a major role in improving the quality of life of people. However, worldwide, infrastructure is ageing and is increasingly being overloaded as a result of factors such as migration, urbanisation and population growth. The South African government has committed itself to a "massive programme to build economic and social infrastructure" through its medium term strategic framework.

The CSIR is well positioned to make a positive contribution with regard to decision support to government, infrastructure provision, enhancement of infrastructure performance through new technologies for materials, structural and functional design of infrastructure, as well as advanced methods of managing infrastructure and the built environment system.

02
PROJECT HIGHLIGHTS

GREEN BUILDING DESIGN TO BE BOOSTED BY NEW CSIR CLIMATE ZONE MAP

Above: CSIR researchers Sheldon Bole, Dr Dirk Conradie (project leader) and Tichaona Kumirai research green building design based on the new CSIR climate zone map.



The CSIR Köppen-Geiger map for South Africa on a very fine 1 km x 1 km grid, distinguishing between 13 primary climate zones. The map is based on 1985 to 2005 Agricultural Research Council data.

A quantitative, hand-drawn world map of climate classification published by Wladimir Köppen in 1931.

The challenge

Changing climates ask for changes in building design

A change in climate demands changes in building design. Climate-responsiveness of buildings is key, regardless of the solutions and technologies employed in the design and engineering of a building. When buildings are designed, the climate of the places where they will be constructed must be taken into account to ensure that they are as energy efficient, and thus green, as possible.

Building design is paramount for improved building performance and optimised internal environmental conditions. Mechanically engineered energy solutions, such as air-conditioning or hybrid strategies could jeopardise energy efficiency. Passive design technologies offer green technology solutions, such as solar heating, thermal mass, natural ventilation, or direct and indirect evaporative cooling.

The current climate map used by built environment professionals in South Africa for design decision-making is contained in SANS 204-2 (2008). Researchers considered the climate map, with two key questions emerging: Is the resolution of the climate information that is reflected adequate to support optimal design in an emerging era of green building practice? What is the likely effect of climate profile change on building performance over a 100-year horizon?

The research

Towards a map to quantify the climate zones

The most frequently used climate classification map is that of Wladimir Köppen, a trained plant physiologist who realised that plants were indicators for many climatic elements. In 1900, Köppen presented the first classification of world climates.

The five vegetation groups of the Köppen classification distinguish between plants of the equatorial zone, the arid zone, the warm temperate zone, the snow zone, and the polar zone. In 1961, Rudolf Geiger produced an updated version of the Köppen

IN BRIEF

The CSIR is committed to promoting sustainability in the built environment and pursues the design of buildings that are responsive to the specific characteristics of the climate in which they will be placed.

According to a new climate map developed by the CSIR to quantify various climate zones in South Africa with improved accuracy, the country has 13 primary climate categories. This is a departure from the current climate map in South African National Standard (SANS) 204-2 (2008), which defines only six climate categories and is currently used in South African design decision-making.

The adoption of the new CSIR-developed Köppen-Geiger map for South Africa would allow building designers to rapidly identify appropriate climate-responsive design techniques.

classification, with Austrian researchers creating a contemporary version in 2005.

Based on the principles of the Köppen-Geiger climate classification map, CSIR researchers pursued the possibility of creating a detailed, new map to quantify the current climatic conditions in South Africa with unique accuracy.

Thirty Köppen-Geiger climatic categories exist worldwide. CSIR researchers used 20 years of precipitation and temperature data to develop their Köppen-Geiger climatic classification map for South Africa.

According to the new map, South Africa has 13 primary climate categories, which is a significant refinement of the six-zone model of SANS 204-2. South Africa's main climate zones include one that is equatorial, four that are arid and eight warm temperate zones.

Simulations of thermal performance of buildings

In building design, insulation and thermal mass are the two key factors for determining the comfort levels, especially when natural ventilation is used. The effective combination of these differs significantly between climate zones, for example, between Cape Town, Pretoria or Durban.

CSIR research indicated that 0.2% of South Africa's area is equatorial, 70.89% arid and 28.91% has a warm temperate climate. The study showed a strong relationship between a particular Köppen region and the expected building performance.

The CSIR team modelled building performance for a typical masonry building and a recently introduced light-weight steel frame building within selected climate zones in South Africa. From this a clear pattern emerged as to the most appropriate passive construction response within a particular climate zone.

Simulations were used to evaluate and compare the performance of the masonry and light-steel frame houses regarding energy consumption for space heating and cooling. Six Köppen regions were used to relate actual building performance to climate region, with weather files utilised for Pretoria, Bloemfontein, Cape Town, Durban, Musina and Kimberley.

Some new material composites were introduced in the materials database to represent typical building materials used in the construction of heavy and light-weight buildings in South Africa. CSIR researchers also calculated the thermal characteristics.

Advanced computational building performance software products make it easier to qualify and quantify the effect of a particular building design before construction. This assumes that sufficient weather files are available to support the process. In reality, weather data suitable for predictive building performance simulation for South Africa are incomplete.

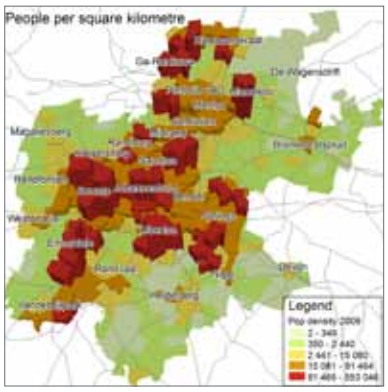
The outcome

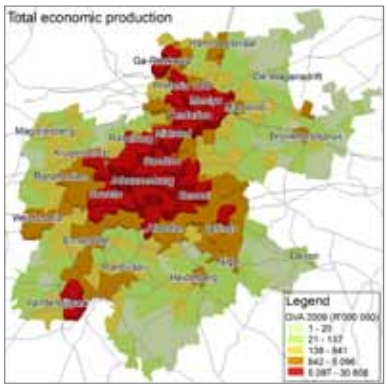
Use of climate-responsive design techniques by building designers

The adoption of the new CSIR-developed Köppen-Geiger map for South Africa will allow building designers to rapidly identify appropriate climate-responsive design techniques. This would facilitate the computational performance modelling of buildings, which would be achieved by applying synthesised approximations of weather data where data are not available.

It is clear to the research team that, if climate change is expressed in terms of Köppen category changes, it is feasible to predict future building performance characteristics within that particular location and craft buildings with these parameters in mind.

Research for the planning of sustainable cities 30 years ahead





The maps indicate the population density (people per square km) and gross value added (economic production), respectively, in Gauteng.

CSIR research has highlighted the need to seriously reconsider current spatial plans, growth management strategies and capital investments. This followed the application of the 'living laboratories' approach in the metropolitan municipalities of Johannesburg, Nelson Mandela Bay and eThekwini.

Such research enables urban planners and decision-makers to proactively accommodate and manage urban growth and expansion in South Africa's metropolitan regions, with urbanisation rates expected to peak at 71.3% by 2030.

The research is conducted using the CSIR's urban dynamics laboratory and a spatially explicit urban simulation platform as part of the Integrated Planning and Development Modelling (IPDM) project, initiated and funded by the Department of Science and Technology.

The CSIR team currently harnesses the synergies between the IPDM project and the Gauteng-focused EnerKey project, a German-South Africa collaboration to develop and implement innovative energy supply and use. The aim of this collaboration is to generate quantitative evidence on the relationship between the urban form and anticipated energy demand in the Gauteng city region.

Using the simulation platform, the CSIR graphically depicts how city-regions will physically change over time, given particular spatial policies or planning scenarios. The spatially explicit simulation results enable decision-makers to anticipate future demand for infrastructure and services. The results can also help cities to assess the medium to long-term impact of large-scale development projects and capital investments.

Researchers render spatial images reflecting spatial outcomes of certain spatial plans and policies, on an annualised basis over a 20 to 30-year period. The growth patterns (time change maps) are underpinned by data and statistics on a range of variables, such as future spatial development typologies; demographic and household profiles; likely consumption patterns; infrastructure and services demand; and travel-demand patterns.

Transfer and uptake of technology for longer-life roads

Tso Nkgapele of the CSIR with an infrared thermal imager to obtain a two-dimensional image of the surface temperatures of the high-modulus asphalt. Temperature control is important to attain the correct degree of compaction.

A full-scale technology trial aimed at longer-life roads was undertaken at the entrance to Durban harbour. The base layers of a stretch of this road were constructed in 2011 – while the road was in full use – utilising a cost-effective road materials technology.

High-modulus asphalt (HiMA) was used, which has improved performance and thus caters for extreme volumes of heavy vehicles entering and leaving that harbour. HiMA technology decreases the life-cycle costs of roads and increases sustainability due to the lower use of non-renewable materials. It can be used on any road carrying heavy loads, including main routes, high-volume urban roads and at airports.

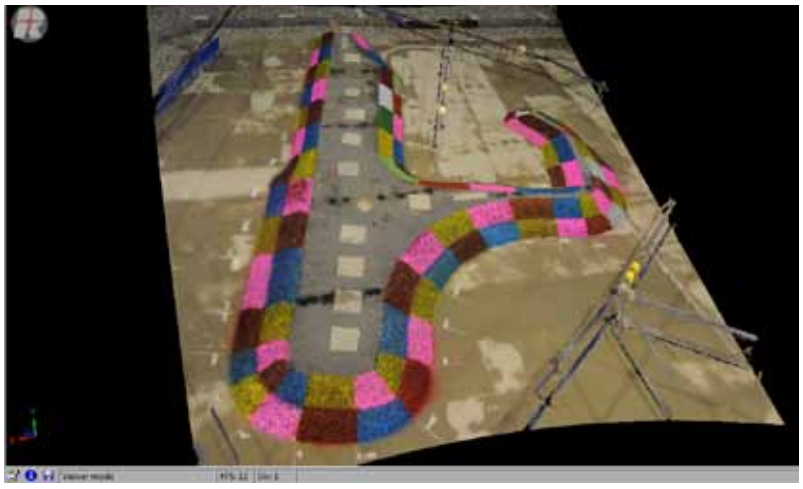
This was the first uptake of HiMA technology, following CSIR research on HiMA mixes suitable for use in South Africa. The organisation was commissioned by the Southern African Bitumen Association (Sabita) to undertake these studies. Researchers used local materials and performance-related testing to develop a product with significantly improved properties compared to conventional asphalt mixes.

Extensive laboratory studies on HiMA mixes by both the CSIR and Sabita led to the development of preliminary guidelines for the design of South African HiMA mixes and roads containing HiMA layers. The guidelines feed into the updated, comprehensive South African Road Design Method developed by the CSIR and others for the South African National Roads Agency Ltd, as well as into a new Asphalt Mix Design Manual undertaken by the CSIR for Sabita.

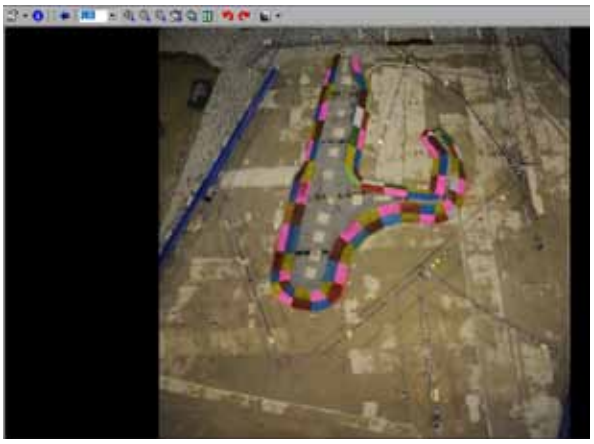
HiMA technology is being considered for use in an integrated rapid transport network plan for one of the major metros.

A density gauge is used to measure the density of the compacted high-modulus asphalt layer; optimal density ensures optimal performance.

Laser scanning strengthens CSIR's damage assessment of breakwater models



A picture-perfect view of the 3D laser scanner's ability to extract colour as well as coordinates of a surrounding area of interest for an Australian project, within seconds of acquisition; compared to the photo of a scanned area (below, left).



Researchers at the CSIR's coastal and hydraulics laboratory have expanded their technological capability by adding 3D laser scanning as a powerful tool for the measurement of damage to small-scale physical models of breakwater built in the world-class physical model hall. The high-definition laser scanner acquired by the laboratory has the ability to extract a picture-like 3D scan of a structure and to produce accurate measurements. Previously, digital images were used to quantify movement by 'blinking' between two fixed images and recording the changes.

With the laser scanner as a damage-assessment tool, the CSIR team was successful in securing a physical model study for the West Pilbara Iron Ore project in Australia. Researchers evaluated the theoretical main-armour design against cyclone wave conditions expected at the location, by comparing the cross-sectional profile at the end of each test series.

CSIR researchers carried out similar physical model studies to assess the suitability of the main-armour design for the proposed West Australian Port of Dampier, for the East Australian Port of Mackay and for the Dawei Deep Sea Port in Burma (Myanmar).

Locally, a research highlight included the modelling for proposed repairs to the Richards Bay South Breakwater. Such repairs involved providing guidelines for the placement of dolos armour units around the South Breakwater for the Transnet National Ports Authority. The CSIR also assessed alternate armour units for the breakwater in a 3D physical model for future design considerations.

Improved low-income houses through innovation

More than 400 community members at Kleinmond in the Western Cape have received improved low-income houses. The Minister of Science and Technology and local authorities officially handed these homes to the owners in December 2011. The housing pilot project was a joint initiative between the Department of Science and Technology (DST), the local municipality and the CSIR. The piloted houses incorporate many features of a CSIR low-income demonstration house developed through research and development.

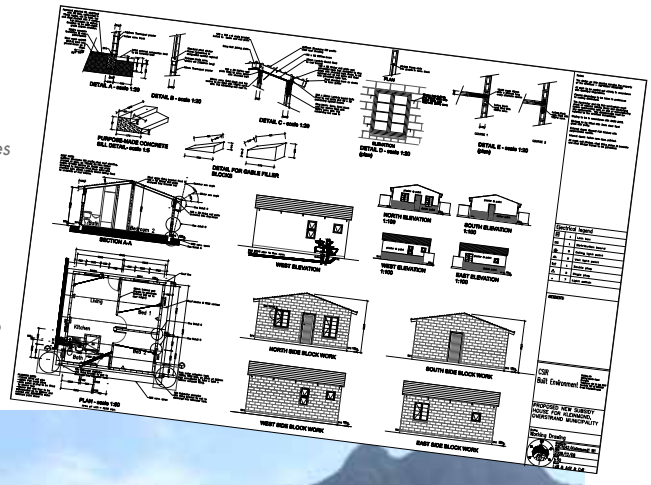
CSIR innovation in design and technology led to the development of an improved, standard-size, government-subsidised house. The CSIR technologies used in the Kleinmond housing pilot can benefit local government, the construction industry and beneficiaries. The local contractor won a special merit award from the Southern African Housing Foundation.

CSIR research continues, including a one-year evaluation of the Kleinmond pilot for the DST, as it shows potential to impact positively on the national government-subsidised housing sector.

In a related project, using the same design as the CSIR demonstration house, BASF, a leading chemical company, has constructed a house with extra, specific insulation technology. The company plays an important role in finding answers to global challenges such as climate protection, energy efficiency, nutrition and mobility.

The insulating panels are from a high-tech material for efficient thermal insulation and environmental compatibility. The building was further enhanced using double-glazed windows. CSIR researchers are investigating the house's thermal properties and energy efficiency. The building and weather conditions will be monitored for a year, with researchers using a simulation model to calculate the energy requirements for heating and cooling the house.

The research results will demonstrate what level of thermal performance this extent of insulation delivers under South African conditions.



The housing pilot at Kleinmond made use of various CSIR technologies and features of a demonstration low-income house. The architect drawing formed part of the first stage of the development of the CSIR demonstration house.

RESEARCH AND DEVELOPMENT FOR

Health

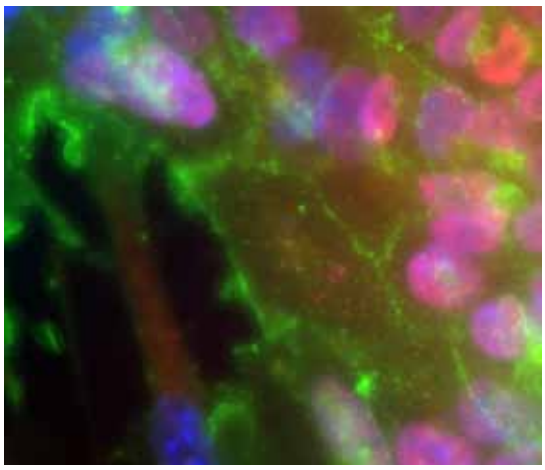
02
PROJECT HIGHLIGHTS

South Africa's challenges in the efficient delivery of health care services are complicated by an enormous burden of disease. The CSIR houses a broad range of multidisciplinary competences that can be mobilised to make a difference in this regard.

The organisation's focus is twofold, to improve the health care system in South Africa and to reduce the impact of the burden of disease. Exciting new technologies are being developed to provide solutions in disease diagnostics, therapeutics, drug delivery, tissue engineering and nutrition. In addition, well-established competences in market and supply chain analysis, logistics, information and communications technology and infrastructure design are harnessed to improve the efficiency of health care service delivery.

Fluorescent microscopy techniques allow the imaging of host-pathogen interactions at a single-cell level. Here, an intracellular bacterial pathogen has hijacked host molecules for motility required in cell-to-cell spread. These bacteria (green) have formed comet tails (intense red) from the host material (dim red), whereas other bacteria (yellow) are in the process of recruiting these molecules. The host nucleus is shown in blue. Combined with high-throughput imaging, such cell-based assays give researchers insight into host factors required for infection, which in turn will lead to new drug targets.

ESTABLISHING LOCAL CAPABILITY FOR BIOMEDICAL STEM CELL TECHNOLOGY



High magnification of induced pluripotent stem cells stained with various stem cell markers indicate their pluripotency: The DNA of the nucleus in blue; the outer stem cell surface-marker in green; and the nuclear stem cell marker in red.

iPSCs are different from classical embryonic stem cells in that they are generated from adult skin samples, yet akin to embryonic stem cells can be manipulated to become any type of cell in the body, such as heart, brain and blood cells. Because these stem cells hold the exact same genetic material as the individual who donated the original skin cell, they would avoid issues of immune rejection when used for cell-replacement therapy in the future.

Background

Reprogramming skin cells into pluripotent stem cells

In 2007, a research team at Kyoto University in Japan developed a method of generating stem cells from adult human skin cells. They called these iPSCs. Since this landmark research, numerous groups have adopted this method as a powerful research tool for developing cellular models of disease and novel cell therapies.

The ability to reprogramme skin cells into pluripotent stem cells has revolutionised the field of targeted disease research. It has provided scientists with the ability to produce previously unimagined, disease-relevant, patient-derived cells in a dish, with which to investigate mechanisms of disease. These models can be used to systematically identify genes implicated in the disease, using genome-wide screening approaches, or for the discovery of therapeutic molecules able to reverse the disease. Part of the novelty of this technology lies in the fact that stem cells can be developed from almost any individual with almost any disease.

The challenge

Acquiring the 'cell capacity' to study diseases pertinent to the continent

Most research exploiting the power of iPSC technology is being developed in Western countries, with little focus on African concerns. South Africa has a number of first-rate researchers, with both scientific and clinical backgrounds, who can exploit such tools. South Africa, and Africa in general, possess a significant breadth of research material and a unique epidemiological context where a very high disease burden is present, including infectious and non-infectious diseases such as HIV, tuberculosis, cancer and neurodegenerative diseases.

IN BRIEF

A group of CSIR researchers is establishing a groundbreaking biomedical stem cell technology, induced pluripotent stem cells (iPSCs), that could hold the key to finding cures to some of the continent's most dreaded diseases.

Furthermore, the ability to generate iPSCs is a profound technical challenge. It requires expertise in a number of molecular and cellular biology techniques, which must be executed simultaneously. Even then, only one in 100 000 skin cells is successfully reprogrammed into stem cells. Thus, the ability to overcome such difficulties and successfully establish this technology is of great importance.

Research

Generating and validating iPSCs

At the CSIR, this technology has now been established by generating iPSCs. These cell lines have been validated using internationally accepted characterisation steps. Researchers are in the process of establishing iPSCs from South African patients to study infectious and non-communicable diseases relevant to South Africa.

The clinical fraternity within South Africa has long been considered a beacon of medical excellence. Therefore, the collaborative efforts of clinicians and scientists can forge a powerful team for establishing unique models of disease.

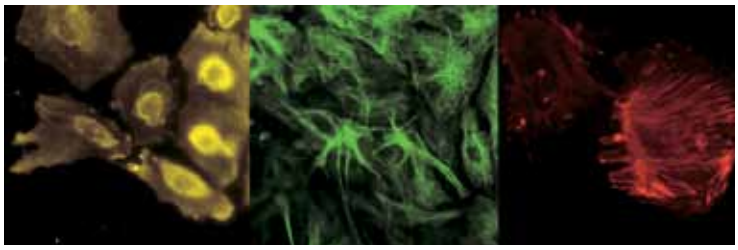
It would further provide a platform for generating research programmes investigating South African and/or African-specific health-related issues. iPSC technology presents an opportunity to attract young scientists in basic molecular and cell biology to the forefront of scientific research.

Outputs

Towards a hub for stem cell research

The development of an iPSC platform in South Africa provides an opportunity for researchers, clinicians, biotechnology and pharmaceutical companies to access a source of infinite cellular material with indefinite plasticity containing unique and diverse African genetic background. These modified cell lines would provide disease models for researchers.

Researchers intend to establish national and international collaborations flowing from the work, providing a hub for stem cell research in South Africa. Ultimately, they also aim for the research to result in the generation of iPSCs for the pharmaceutical industry in the areas of research and development, drug screening and tissue engineering.



Images showing liver (yellow), neuronal (green) and muscle (red) cells which have been differentiated from induced pluripotent stem cells (iPSCs) made at the CSIR. These various cell types are an exact genetic copy of the iPSCs and can be used to create 'disease-in-a-dish' models of pathologies that affect neurons, muscle or liver cells.

Dr Janine Scholefield imaging induced pluripotent stem cells on a custom-built, super-resolution PALM/STORM microscope, built by the CSIR's Dr Musa Mhlanga and former PhD student Dr Ricardo Henriques.

CSIR postgraduate students rise to the tuberculosis challenge

From left are Charlotte Maserumule, Nqobile Ngubane, Tozama Ogunleye, Anjo Theron and Lia Rotherham, examining the growth of a gram-positive bacterium for their research on tuberculosis.

A group of CSIR postgraduate students studying towards their Master's and PhDs has made noteworthy progress in addressing the tuberculosis (TB) challenge. Three of their projects show great potential in the development of novel, improved TB therapeutics and point-of-care diagnostics.

The first project explores the use of *Mycobacterium tuberculosis* enzymes as possible drug targets. A library of compounds has been screened for inhibition of these enzymes, which resulted in two validated hits. These two compounds represent excellent starting points for a hit-to-lead campaign to develop selective, druggable agents, capable of selectively inhibiting TB enzymes.

The second project, also focusing on drug development, exploits the application of enzymes to assess organic compounds. Biocatalysis, a relatively new technology in the country, has been used to successfully synthesise a library of compounds using laccase enzymes. These compounds were screened against multidrug-resistant (MDR) TB strains and they exhibited potent growth inhibition. Further work entails structural modification of organic compounds to optimise the growth inhibition exhibited against MDR TB strains.

The third project aims to enable early and accurate diagnosis of TB. Two classes of novel TB detection molecules, called aptamers, have been generated for the development of lab-free TB diagnostic tools. These TB-detecting aptamers have been characterised and validated in a proof-of-principle case-control clinical study, with high sensitivity and specificity values. The potential product from this work is a TB detection system that is simple, rapid, accurate, and affordable.

Biological production system for human therapeutics from soil bacterium

Innovative technologies have been developed at the CSIR for the cheaper production of peptides. Peptides are the building blocks of proteins and are increasingly used in new drugs. In the local context, research is driven by the need for the cost-effective production of an antiretroviral therapeutic currently inaccessible to African countries due to high production costs.

The innovation includes the development of a new expression host, isolated from local soil, as well as expression technologies in yeast and plants.

Bacillus halodurans, a bacterium isolated from a soil sample near Bela-Bela in Limpopo, produced a surface-located protein at high levels in relation to other proteins. This protein was later identified as flagellin, the main building block for flagella. Display technology was developed and patented which led to the technology being incorporated as a viable host for therapeutic peptide production within a biotechnology spin-off company. The host bacterium was then genetically modified to take advantage of the flagellin secretion system to produce recombinant therapeutic peptides.

The process development for production by the soil bacterium was done in collaboration with the Technical University of Berlin and was funded by the Technology Innovation Agency. The work was further supported by an SA/German bilateral project funded by the National Research Foundation.

The problems facing the peptide industry include low stability of the peptide (quick degradation and clearance from the body); low oral bio-availability (injection required); difficult delivery (cross-membrane transportation); as well as challenging and costly synthesis. The high cost to the patient makes treatment by most drugs, based on pharmaceutical peptides, unaffordable in poorer countries, thus making these excellent drugs unavailable to patients in Africa. Recombinant production technology is an alternative that allows for the cheaper synthesis of these long-chain peptides.

The CSIR's Dr Michael Crampton examines a bacterium isolated from a soil sample and genetically modified to take advantage of the flagellin secretion system to produce recombinant therapeutic peptides.

CSIR and Nestlé partner to support development of nutraceutical and health products

The CSIR has signed a partnership agreement with Nestlé aimed at an R&D programme to evaluate the potential of South African indigenous biodiversity as nutraceuticals and functional foods with proven health benefits.

The partnership will enhance the CSIR's capacity to better understand industry development cycles and requirements for the commercialisation of such products.

In addition, it will add value to the country's indigenous resources through exposure to modern technologies in developing new food-based products.

New products developed through the collaboration will be manufactured in South Africa in compliance with international standards, leading to the development of new skills and ultimately creation of new jobs in the biosciences industry. The work will focus on a variety of African plants, such as leafy vegetables that have long been known by rural communities to be an essential food that is consumed with carbohydrate staples. These vegetables have high nutritional value that could play an important role in the prevention of malnutrition and as a potential nutraceutical source.

Dr Rachel Chikwamba, CSIR Group Executive for Strategic Alliances and Communication, pictured with Professor Peter van Bladeren, Global Head of Regulatory and Scientific Affairs of Nestlé SA during the signing of a memorandum of agreement.

Transfer of genetic material into cells using light strengthens local research

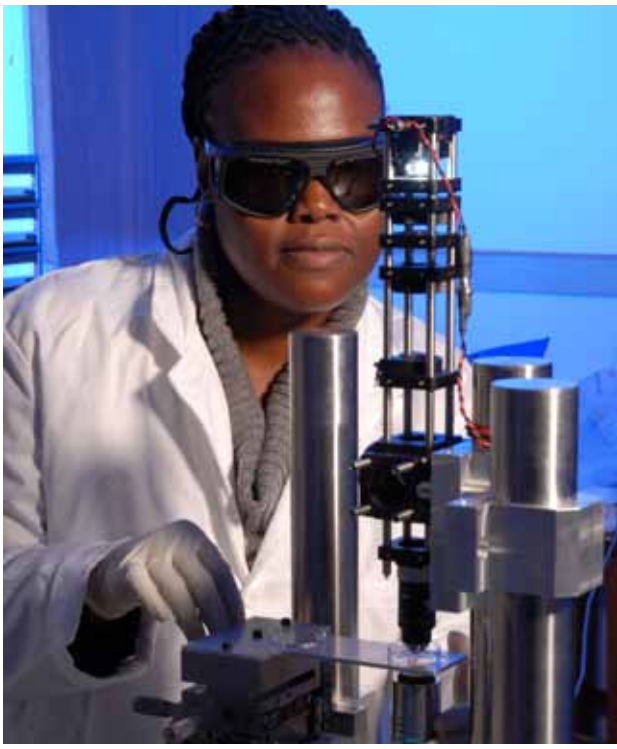
Image A shows how hamster ovary cells have absorbed a blue dye after treatment with the laser technology; Image B shows the cells before being exposed to the laser – they do not take up the dye automatically; Image C shows how too much laser exposure resulted in leaking of the cell contents.

The ability to deliver foreign genetic material into a cell using only laser light, coupled with earlier advances in the ability to sort cells using laser light, is strengthening the CSIR's potential to make a significant contribution in health interventions using laser technology.

CSIR scientists are now able to use laser light to 'punch small holes into living cells' to deliver a range of substances, for example DNA/RNA. This process is called photo-transfection and its value lies in the fact that the micro-hole made by a femtosecond laser beam is so small that cells regenerate the membrane on the site of laser treatment and selfheal. Unlike chemical, viral or even physical methods, the process does not harm cells, while allowing the introduction of a wealth of other micro-materials, such as therapeutic agents, including drugs or genes.

Another example of the use of this process is cellular inclusion of biological dyes, which assist in the internal marking of certain cell components and as a result, permit intricate studies of both cellular function and studies towards understanding diseased conditions. Additional benefits are that photo-transfection set-ups can be easily integrated with other optical techniques such as confocal laser-scanning microscopy and optical tweezers.

The CSIR is in the process of setting up a photo-transfection laboratory which is partly funded by the Photonics Initiative of South Africa. The organisation's expertise in beam shaping can be combined with its tweezing and photo-transfection processes. This combination could potentially result in a highly efficient system with significant benefits in the health domain.



CSIR scientists, led by Dr Patience Mthunzi, have successfully transfected neurons using a 1 064 nm laser. The photo-transfection work is conducted at petri dish-level with aspirations to take it to animal studies in the foreseeable future.

Nanomedicine research programme awarded Centre of Excellence in health innovation status

The CSIR's nanomedicine research programme, funded by the Department of Science and Technology, was awarded Centre of Excellence in health innovation status by the African Network for Drugs and Diagnostics Innovation (ANDI). Based at the United Nations Economic Commission for Africa in Ethiopia, ANDI promotes and sustains African-led product research and development innovation through the discovery, development and delivery of affordable new tools.

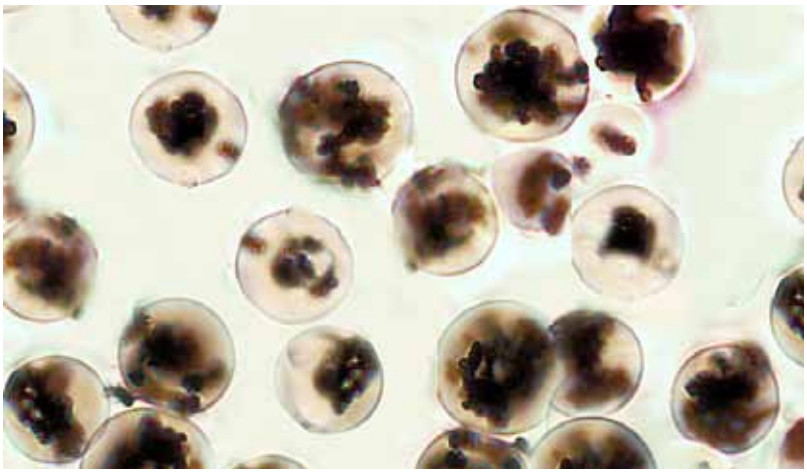
The field of nanomedicine has a great number of applications. The CSIR's work pertains specifically to the repackaging of already existing medicines for poverty-related diseases such as tuberculosis (TB), using nanotechnology, in order to enhance the efficacy of the medicines.

The new status is set to create several opportunities that can assist with the centre's goal of researching and developing solutions for poverty-related diseases through nanomedicine. It has already led to approaches for collaborations, a heightened interest from researchers to work in nanomedicine and greater access to funding sources.

To the researchers, the new status means that some of the medicines developed in Africa, but shelved because of clinical failure, can now be revisited and reformulated through nanotechnology. This could assist with the commercialisation of more African products. Through several initiatives, the centre will also assist with the development of human capacity to alleviate the critical skills shortage on the continent.

The CSIR's nanomedicine research programme, funded by the DST, was awarded Centre of Excellence in health innovation status by the African Network for Drugs and Diagnostics Innovation. Dr Hulda Swai, who heads the centre, prepares a dissolution bath for experiments.

ReSyn™ technology on track for life sciences R&D applications



The first microspheres were solid balls that could bind molecules only on their outer surface. ReSyn™ microspheres consist of many strands coiled together like a ball of wool so that molecules can bind on the surface of every strand. This is a light microscope image of magnetised ReSyn™ microspheres, with the iron oxide (used to magnetise them) – trapped inside the microsphere. Proteins, DNA and other bio-molecules can be trapped by the microspheres, which can then be removed from complex mixtures using magnetism.

A novel microsphere technology to improve the sensitivity of diagnostic devices has been further enhanced.

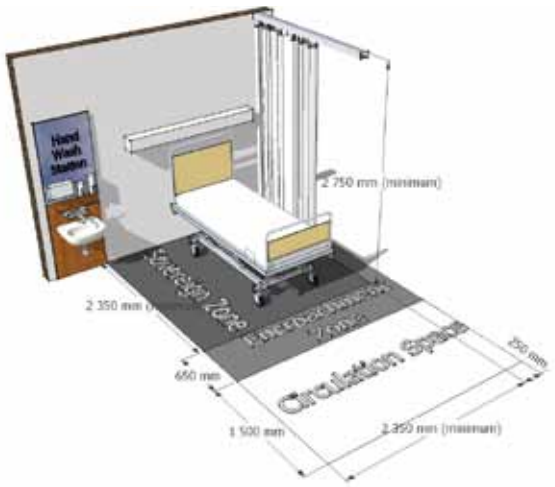
Microsphere technologies are used routinely in research and industry. For example, they allow the separation of biological molecules like proteins and DNA from complex samples, and they keep active molecules in place during drug discovery. They are also used to trap molecules in various diagnostic technologies.

By drastically increasing the surface area to which bio-molecules bind, as compared to older technologies, ReSyn™ microspheres enable the development of highly efficient and highly specific products.

ReSyn™ Biosciences – a bio-tools company originating as a spin-out from the CSIR – will initially focus on manufacturing MagReSyn™ magnetic microsphere products for research and development in life sciences applications.

During the year under review the CSIR team conducted product and process development that has resulted in five market-ready products.

Improving public health care infrastructure through collaboration



Visual aids to determine space requirements for adult in-patient accommodation.

The CSIR and its partners have made significant progress in developing a set of norms and standards for health care infrastructure that heeds the South African context, constraints and service delivery objectives.

This resulted from a three-year project, which started in 2010, with close collaboration between the Department of Health (DoH), the Development Bank of Southern Africa and the CSIR. The overall aim of the Infrastructure Unit Systems Support project is to optimise the country's health care infrastructure through all stages of the infrastructure life cycle. The project was initiated by the DoH in response to documented under-expenditure of allocated budgets for public health care infrastructure and acknowledgement of challenges in the acquisition, quality, delivery, operation and maintenance of health care facilities.

CSIR researchers who are part of the team working on the Infrastructure Unit Systems Support project, a multi-year, multi-million collaborative initiative.

The CSIR is leading two of five interlinked focus areas. In the first, norms, standards and guidelines for health care facilities are being developed across 45 work packages, ranging from clinical services like wards, theatres and intensive care units, to cross-cutting issues such as building engineering services and infection prevention and control. CSIR competences in quantity surveying, mechanical engineering, architecture, software development, building performance analysis and computer-assisted design are employed. Some 20 information gathering workshops for clinical and infrastructure professionals have been held to date to ensure that stakeholders have the opportunity to provide their inputs. Drafted documents are released for input and early adoption at www.iussonline.co.za

The second CSIR-led focus area revolves around the development of a health care infrastructure cost-modelling capability. This decision-support tool can be used to project expenditure during the various life-cycle phases for various categories of health care facilities. The modelling takes both the cost of the infrastructure and the cost of operating facilities into account.

INVESTMENT IN

Advanced research infrastructure

A continued commitment to world-class research and development (R&D) infrastructure saw the CSIR acquiring several new facilities and sophisticated equipment. A few highlights from the past financial year are summarised.

Africa's first laser-engineered net-shaping system

In an exciting development for local advanced manufacturing, a laser-based additive manufacturing system has been established. Additive manufacturing relies on energy-deposition technologies to fuse material into three-dimensional parts, one layer at a time, using a high-power laser. This enables the building of parts such as turbine blades and hip implants as well as the repair of worn or damaged parts. The introduction of specifically titanium-additive manufacturing is eagerly anticipated.

New bioprocessing facilities

An investment of R50 million has given rise to new pilot manufacturing facilities for botanical products, biologics as well as chemical processing. These facilities will make it possible to translate bioprocessing discoveries to market-ready products for players across the innovation landscape.

Leap-frogging the localisation problem of mining robots

For a robot to interact with its environment, it needs to know where it is. Because the CSIR is investigating the use of robots in the context of mining – with global positioning systems not an option for underground localisation – a high-quality localisation algorithm is essential.

The CSIR acquired a high-end motion-capture system with sub-millimetre accuracy. The Vicon system allows users to track any movement through multiple, passive, infrared reflective markers. By using these markers, the system is able to determine an exact location.

Hydrogen storage laboratory

Hydrogen fuel cells are an exciting energy alternative from the perspective of reduced emissions and guaranteed supply of energy using renewable energy such as solar and wind. South Africa's interest is further heightened by the abundance of the raw materials (the platinum-group metals) needed to catalyse the electrolysis of water to generate hydrogen and oxygen and to convert hydrogen into electricity. As hydrogen has a low density, challenges remain around storage.

A new state-of-the-art hydrogen storage laboratory at the CSIR enables researchers to synthesise, characterise and do performance testing of candidate hydrogen storage materials. Some of the materials investigated include nanoscale structured materials such as metal organic frameworks.

Facilities for R&D in defence and security

A 'roof laboratory' and office expansion is underway to support research in target and object identification, classification and tracking over very long distances under different lighting and atmospheric conditions. Multi-spectral, long-range cameras, zoom cameras and very wide field-of-view equipment will be installed and data will be streamed to researchers involved in these experiments.

Deputy Minister of Science and Technology, Mr Derek Hanekom, officiated at the launch of the new additive manufacturing facility at the CSIR. A close-up view of the laser-engineered net-shaping system is seen below.

Bench-scale reactors at the new bioprocessing facilities.

RESEARCH AND DEVELOPMENT TOWARDS AN INCLUSIVE

Information society

02
PROJECT HIGHLIGHTS

Information and communications technologies have provided the foundation for a number of advances that have seen the world transform in recent decades. The extent to which countries are accessing, using and building skills in these technologies is determining their impact on enhanced well-being and economic advancement.

In addition to providing thought leadership in this domain, the CSIR focuses its efforts on enhancing ICT readiness by addressing access gaps; promoting digital literacy and enabling inclusion; as well as intensifying ICT usage by addressing key government ICT capabilities.

CSIR researchers have identified a new concept, based on the use of ultra-low-power electronically controlled array antennas, which can potentially reduce the power consumption used for radio frequency transmission in low-power wireless sensor network devices by an order of magnitude. This would offer a much longer battery operation life for these systems or new applications. Pictured above is part of a prototype.

IMPROVED SUPERCOMPUTING, DIVERSIFIED USER BASE AND NEW DATA CENTRE FOR CHPC

Above: The hard drives of the Data Intensive Research Infrastructure of South Africa are carried on this WOS node. Data of national importance are preserved here.

CHPC technicians and engineers constantly ensure that systems are in mint condition to support the growing user base.

Drastically increased processing power

African researchers from academia and industry now have access to a facility that is able to process over 60 trillion cycles of instructions per second. This capability significantly enhances research and addresses grand challenges across all academic disciplines. The CHPC is funded by the Department of Science and Technology (DST).

In November 2011, the centre's Sun Tsessebe Constellation cluster joined the world's top ranking supercomputers, a list known as the Top500, slotting in at 329th place, based on its computing capabilities. This international accolade followed the cluster's October 2011 upgrade, worth R9 million. This boosted the cluster's performance from a peak performance of 21 to 61 teraflops.

The upgrade was led by CHPC engineers who worked with engineers from Cambridge University in the United Kingdom and Eclipse Holdings. Among other things, the upgrade required labelling and installing 88 power cables, 176 network cables and 176 infiniband fibre cables. The system is made up of Oracle's Sunblade X6275 blades with Intel Nehalem 8 core processors and Westmere 12 core processors, as well as Dell's Poweredge C6100 servers with Intel Westmere 12 core processors. It has a new theoretical peak performance of 74 teraflops. Large projects, such as the Square Kilometre Array and others, now have increased processing power at their disposal.

Large-scale simulations of galaxy evolution that are required to interpret data from radio telescopes and plan MeerKAT surveys, have been done using facilities at the CHPC. Analysis of radio data has led to new information on the relationship between dark and luminous matter in the universe.

Storage and access of data of national importance

Users of the CHPC are now able to access, deposit, store, and manage data effortlessly from any location, with sufficient Internet

IN BRIEF

The Centre for High Performance Computing (CHPC) has improved its supercomputing capabilities through an upgrade of its Sun Tsessebe Constellation cluster; launched South Africa's data centre; and established an industrial advisory council. Furthermore, a national meeting drew about 300 local and international delegates while special efforts were undertaken to engage students on the latest developments in high performance computing.

access. This follows progress on the formation of the third pillar of the South African Cyberinfractructure, the Very Large Data Base.

At the end of the financial year, the CHPC completed the first phase of this undertaking, which involved putting in place the R17.5 million, fully synchronised data storage system between the Pretoria and Cape Town sites. The infrastructure has a storage facility of two petabytes and is accessible through the SANReN network. It operates at a full capacity of 10 gigabits per second and provides the latest technology based on open source software to enable CHPC users to define their own rules in data acquisition, sharing and curation.

This first phase was funded by the DST, following a positive report on the 2007 feasibility study. This project has been extended and renamed the Data Intensive Research Infrastructure of South Africa (DIRISA). This was done to incorporate the long-term archiving and preservation of data that may not be physically large, but are still of national importance. The CHPC has completed the full migration of data portals in climate modelling, astronomy and Earth observation, with humanities, medical applications on rheumatic heart disease data and bio-informatics data on genomic sequencing to follow.

Work is also underway on the identification and curation of critical research data to make the data accessible to a wider community. DIRISA utilises a Web Object Storage (WOS) 2.0 system. WOS delivers greater storage efficiency – compared to conventional SAN/NAS file systems – by utilising at least 25% more available disk platter space.

High performance computing for a competitive industry

Higher education institutions and research councils have been the main users of the centre's facilities since its formation. However, ever-mounting pressures on industry to grow their business and to become more competitive, have led a number of companies to the CHPC. Sasol, Hatch and others are using the centre to conduct computationally intensive research to increase their competitive edge. They have access to CHPC facilities without a long-term commitment, which translates into cost-effective access.

To improve service to industry, the CHPC 2011 national meeting established the Industrial Advisory Council. The council, made up of CHPC users from industry, meets twice a year and is a platform for South African companies to give advice on CHPC policy, strategy and implementation as it pertains to industry. It is a forum to identify and discuss competitive issues around the adoption and use of high performance computing. The nature of the research objectives of CHPC's newer users from industry typically include advanced manufacturing, for example, advanced production and processes, knowledge intensive manufacturing and smart products and systems.

CSIR completes phase 1 of SANReN

With the completion and commissioning of the Cape Town metropolitan fibre network, and the completion of 10 gigabits per second (Gbps) links to both the South African Large Telescope (SALT) and Square Kilometre Array (SKA) sites, Phase 1 of the South African National Research Network (SANReN) has been completed.

SANReN is a high-speed network that aims to connect more than 200 research and higher education sites around the country with one another and with international research and education organisations around the globe. It is part of the DST's national cyber infrastructure initiative and complements the Centre for High Performance Computing and the Data Intensive Research Infrastructure of South Africa project. The Department of Science and Technology (DST) had tasked the CSIR with the rollout of the network. SANReN is operated by TENET.

The upgradeable, high-speed broadband link that was installed between Cape Town and the SKA site satisfied the data transport needs of South Africa's successful bid to host the world's biggest telescope, along with Australia.

SANReN's phase 1 network connects 105 institutions with 10 Gbps links. SANReN's users include all 23 higher education institutions, eight science councils and seven national facilities – some 450 000 people. The total investment in SANReN for phase 1 is R429 million (including funding to connect the SALT and SKA sites).

The overall network architecture consists of a national backbone connecting Durban, Pretoria, Johannesburg, Bloemfontein, Cape Town, Port Elizabeth, East London and back to Durban on a 10 Gbps ring network. Metro rings have been installed in Johannesburg, Tshwane, eThekwini and Cape Town. A second phase of the SANReN project is extending the backbone to more remote sites including Polokwane, Grahamstown, Makhado, Mthatha and Mahikeng, among others. SANReN provides international connectivity via the SEACOM submarine cable through an arrangement with TENET.

A map indicating the status of SANREN, with work in progress indicated in orange.

A CSIR co-creation makes it to *Time Magazine's* top 50 inventions of 2011

Time Magazine has listed the Digital Drum – a CSIR and United Nations Children's Fund (UNICEF) co-creation – one of the 50 top inventions of 2011.

The Digital Drum is two computer work stations housed adjacent to one another in an oil drum kiosk. It is designed to give people access to relevant information on various topics, including health and education. The concept is taken from the CSIR's Digital Doorway, a robust standalone computer system aimed at promoting self-learning in computer literacy. The Digital Doorway initiative is funded by the Department of Science and Technology (DST).

The UNICEF-CSIR team was given the task to come up with a similar solution in Uganda. However, manufacturing a similar design to the Digital Doorway, which has steel housing for the computer work stations, proved a challenge in Uganda as suitable equipment and technologies to manufacture to specifications were not readily available in the country.

An elegant solution to the problem was found in the form of an oil drum. Oil drums are readily available. The team then worked on a prototype that could be mounted horizontally on the wall, with two computers inside facing away from each other.

The original prototype and the subsequent iteration of the Digital Drum using a second oil drum as a stand, is on display at the Cooper-Hewitt National Design Museum in New York City. It features in the museum catalogue, *Design with the other 90%: Cities*.

The Digital Doorway project has been operational for 10 years and to date more than 200 units (robust, multi-terminal, multimedia computer systems) have been deployed throughout South Africa in mostly deep rural settlements. An outcome evaluation project, funded by the DST and completed in March 2012, concluded that Digital Doorways are a significant resource in creating a new generation of computer literate people in the areas they serve by lowering the barriers to computer and information literacy.

Users of the Digital Drum in Uganda. CSIR researchers worked with staff at the UNICEF Uganda office to come up with the prototype.

University of KwaZulu-Natal and CSIR join forces in artificial intelligence research

The University of KwaZulu-Natal (UKZN) and the CSIR have joined forces to form the Centre for Artificial Intelligence Research (CAIR), thereby becoming one of the largest groups conducting research on artificial intelligence in Africa.

CAIR is associated with the School of Mathematics, Statistics and Computer Science at the College of Agriculture, Engineering and Science at UKZN. The centre now has seven permanent members; four associates; two postdoctoral fellows; 18 full-time PhD and MSc students; and 16 part-time PhD and MSc students.

The significance of establishing the centre is in creating critical mass in the area of artificial intelligence, thereby combining methodologies and techniques developed in different sub-areas of this field, to discover novel solutions to difficult problems.

Already strong links have been forged between two research areas, namely the group on knowledge representation and reasoning, and the health architecture laboratory. These groups now investigate novel ways of representing clinical data, knowledge and processes so that decision-makers at the patient, district, provincial and national levels are more informed and make decisions that achieve optimal positive health outcomes. One of the projects involves using the clinical characteristics of an HIV patient to predict the impact of the patient's genetic makeup on drug resistance. This is used to determine which patients should undergo expensive gene testing.

The University of KwaZulu-Natal (UKZN) and the CSIR have jointly formed one of the largest artificial intelligence research centres on the continent. Pictured is CAIR Deputy Director and Senior Lecturer in the School of Computer Science at UKZN, Dr Deshendran Moodley. Prof Thomas Meyer of the CSIR is the Director of CAIR.

Mobile application developed to simplify collection of speech data in any language

Field worker, Johan Mphikeleli Zwane, explains the use of the mobile application, Woefzela, to record speech data that will enable researchers to develop automatic speech recognition systems.

The CSIR has developed an Android-based mobile phone application that simplifies the collection of speech data in any language. This specific development was funded by the Department of Arts and Culture with the aim of promoting language equity for information access in all 11 official languages of South Africa.

Significant research and development led to this mobile application. The CSIR developed all the necessary tools to collect the data, perform quality control on the data and build a large and structured set of texts and speech data. The research team used the resulting corpora to do additional R&D of systems and algorithms related to speech recognition.

The data collected from the Android-mobile application will be used as part of a National Centre for Human Language Technology Speech Resource Development project to develop automatic speech recognition systems for all 11 languages.

The researchers hope to help in creating an information access 'framework' to allow people access to relevant information on government services in their own language.

Some of the corpora have already been used successfully in various research projects to improve automatic speech recognition performance and to investigate or develop related algorithms for quality control and system development. In its final form, the corpora will be open source and will advance speech technologies for South Africa's official languages and ultimately contribute to a human language technology industry in South Africa.

Piloting video streaming to mobile devices

The CSIR's novel Internet-streaming-to-mobile technology: the handheld smart phone and the screen carry the same information.

Information and entertainment from the Voice of Wits (VoW) campus radio station is now just a click away for students, staff and various communities in and around the University of the Witwatersrand. Based on novel CSIR Internet-streaming-to-mobile technology that adapts the image to the quality of the infrastructure, and with connectivity provided by the South African National Research Network (SANReN), this pilot project carries the full support of the Dean of Humanities, Prof Tawana Kupe, and the VoW station manager, Mr Mike Smurthwaite.

Operated by Wits students, VoW has a listenership of about 11 000. Real-time Internet streaming-to-mobile technology has increased its reach beyond its physical broadcast range. Through SANReN, it is possible to develop an interactive university community connecting South African campuses. Live studio broadcasts and social media provide a new and engaging platform for viewers to interact.

By extending the lower range of the international video-coding standards, the CSIR team can enhance the picture quality at the low bit-rate end of the market. This heralds an era of creativity for broadcasters and advertisers. Findings from the pilot will inform commercial applications of the Adaptive Real-time Internet Streaming Technology (ARTIST), such as television broadcasts, which is being explored with Tuluntulu Pty Ltd.

Consortium members in the ARTIST project (funded by the Technology Innovation Agency) are the CSIR, East Coast Access and the University of Cape Town.

The Voice of Wits (VoW) pilot in action, from left: the CSIR's Dr Keith Ferguson, Mr Pierre van Houten of Tuluntulu Pty Ltd, the CSIR's Simeon Miteff, Prof Tawana Kupe of Wits, and the VoW station manager, Mr Mike Smurthwaite, with VoW DJ, dj@large, Mr Tshepo Kgapane.

Technology in Government in Africa award for Dr Math™

A CSIR-developed mobile mathematics tutoring programme received a Technology in Government in Africa award in Dar es Salaam, Tanzania on 27 May 2011. The United Nations Economic Commission for Africa, in collaboration with the government of Finland, selected Dr Math™ as a winner in the category 'ICT in Education'.

Dr Math™ primarily uses Mxit as a platform though it can use similar open chat platforms. The CSIR is aiming to grow its registered user base to its award winning Dr Math™ programme from the current 30 000 to 100 000. Since its launch in 2007, the uptake of the programme has been driven mostly by word of mouth. The CSIR now plans to take active steps to communicate Dr Math™ through various initiatives using a mix of media outlets.

Funding from the Department of Science and Technology, and collaboration and support from the Department of Basic Education and Mxit have been instrumental in the on-going success of Dr Math™. In addition, Dr Math™ is part of the Hewlett-Packard Catalyst Initiative 'New Learner' consortium. This initiative is a global social innovation programme designed to develop more effective approaches to science, technology, engineering and math education. Through this initiative, the CSIR received a grant of HP technology to the value of R1 million, including laptop computers and servers, all of which have been donated to various schools and Dr Math™ tutors.

Dr Math™ tutors are mostly drawn from the University of Pretoria (UP). Since 2007, these students have been doing Dr Math™ in fulfilment of a compulsory undergraduate module, which is a community-based project. Tutors also come from the African Institute of Mathematical Sciences, a centre for education and research in Cape Town.

The creativity of CSIR researcher Laurie Butgereit (right) first sparked the development of Dr Math™. Through Dr Math™, learners have access to a group of registered tutors who are online to receive their requests for help via Mxit, a popular chat service. CSIR principal researcher Dr Adele Botha (left) received the award (featured top) on behalf of the team.

RESEARCH AND DEVELOPMENT IN SUPPORT OF

Service delivery

02
PROJECT HIGHLIGHTS

Effective planning and delivery of socio-economic development and basic services to communities remain a national priority. Guided by its mandate, the CSIR supports government's service delivery mandate through integrated, multidisciplinary research and technological innovation.

The aim is to transfer CSIR-developed technologies and solutions to address service delivery needs. Science, engineering and technology are powerful enablers for improvement in service delivery.

Typically the CSIR's involvement in service delivery occurs through one of three mechanisms:

- Ongoing research and development initiatives championed by research teams at the CSIR
- Integrated demonstration projects and initiatives, drawing on several research competences with a greater focus on implementation and maximising impact
- High-impact initiatives, led by the CSIR, utilising its expertise, and partnering with players in the South African National System of Innovation, with national and regional focus and impact.

Examples of CSIR interventions for service delivery include work done on water supply and management; sanitation, health and electricity; improvement of roads and transport, housing and waste management; and access to information.

Remote, rural communities without water services are vulnerable to water-borne diseases from unsafe drinking water, as evidenced by the number of cholera outbreaks in the Eastern Cape. Safe and reliable potable water is now available to some rural communities in the Amathole and the OR Tambo municipal districts through accelerated sustainable water service delivery pilot projects. Communal water stations, located close to traditional collection areas at a river, provide safe drinking water through taps at water stations in the villages.

CSIR publication highlights municipalities' innovation when dealing with waste

The publication highlights several examples of municipalities having overcome challenges related to waste management.

CSIR researchers compiled a guideline of good waste management practices in rural and urban municipalities serving as an example of how obstacles related to municipal service delivery can be overcome.

Research into the obstacles and challenges facing municipalities in providing waste management services has shown that different municipalities face similar problems. However, several municipalities manage to provide sustainable waste management services despite these difficulties.

Researchers identified good waste management practices in municipalities by studying those municipalities that continuously did well in the Cleanest Town Competition; those identified by previous research; and those recommended during a workshop in 2008. The research team identified and visited 23 municipalities that constantly performed well. Good waste management practices were documented to share the learning between municipalities.

The research results were summarised and published in a reader-friendly publication, *Municipal Waste Management – good practices*, which was launched in 2011.

Residential waste collection optimised through modelling and algorithms

Using its expertise in industrial engineering and supply chain management, the CSIR developed and successfully tested a software tool that can enable a typical South African municipality to reduce its waste collection and transportation costs by more than 20%. The tool optimises municipal household waste collection and transportation scheduling activities.

These results follow a CSIR-conducted case study on waste collection service delivery in Wattville, situated in the metropolitan municipality of Ekurhuleni. The underlying models and algorithms were developed for the optimisation of collection routes, area sectoring, transfer station location analysis and for determining optimal vehicle fleet size and composition.

Six of South Africa's major metropolitan cities had a budgeted waste management expenditure of close to R5.7 billion during 2011/12. Waste collection and transportation are known to be the most costly component of this, and can account for 50 to 80% of a city's solid waste management budget, thus making it a promising area to target for cost reductions. The highly repetitive nature of household waste collection means that even a small improvement in the process can lead to significant cost savings.

The software tool can be used in any municipality, providing that it has an electronic map of its streets, including a location of dumpsites, a vehicle depot, and waste-generation quantities for its service areas.

Some key challenges faced by municipalities include budget restrictions, insufficient skills development and a lack of in-house capacity. The CSIR can provide municipalities with expertise relating to implementing the tool, analysis of waste removal operations and associated trouble-shooting.

A CSIR-developed software model can be used by municipalities to cut costs of household waste removal considerably though optimisation of collection schedules, vehicle fleet sizes and other factors.

Pioneering a remote monitoring and measurement solution for water treatment plants

The CSIR has developed a technology solution that measures and monitors effluent quality on an on-going basis at water treatment plants.

The solution informs plant managers by means of cellular or Internet alerts of any deviations from predetermined limits in water quality. As a result, managers now have constant access to information about the plant, enabling them to rapidly intervene when necessary. In addition, because data are logged on a server, historical reports can be obtained to monitor plant performance and trends over an extended period.

Samples of effluent are pumped into a sample rig at regular intervals.

A set of probes inserted into the water then monitors the levels of certain critical elements. The generated data are transmitted through the web to a CSIR management server. CSIR-developed software reports the measured readings as well as a number of other water quality indicators derived through proprietary models and algorithms.

This tool assists water treatment authorities operating on restricted budgets and without sophisticated analytical laboratories in their endeavours to comply with legal requirements and ensuring the down-stream health of humans and the environment.

The CSIR's Calie Adlem inspecting a remote monitoring system installed at a water treatment plant.

Accelerated service delivery to bring potable water to remote, rural villages in the Eastern Cape

Children from the nearby community collecting safe, sustainable drinking water from taps. The water is pumped from the communal water station to a small storage tank, from where gravity carries the water in pipes all the way to taps in the village.

Various renewable and alternative energy supply options were investigated for the communal water stations. Solar power, as seen at this communal water station, with diesel generators as back-up was found to be the most suitable.

A successful pilot project has brought reliable, safe water to some 9 000 people in six villages in the Amathole and the OR Tambo district municipalities. The Department of Science and Technology initiated and funded the project for accelerating sustainable water service delivery to remote, rural villages in these two areas in the Eastern Cape.

Water-borne diseases from unsafe drinking water are a reality in these rural areas where people often share water from rivers, springs or wells with domestic animals. These communities now benefit from safe drinking water through the application of appropriate technology, which augments municipal water services. 'Appropriate technology' means that methods used to supply water to communities must be cost-effective; relevant to the area; easy to use by communities; culturally and socially acceptable; easy to maintain; and friendly to the environment.

The hallmark of this project was community participation, which was the focus of the Human Sciences Research Council. Partnerships with key decision-makers in the three tiers of government were crucial, with the Ministry of Science and Technology taking the lead.

Implementing the recommended solution saw water being pumped from traditional collection places at a river to a nearby communal water station, where it is treated and pumped to water points in the village. The CSIR also provided guidelines for the protection of springs and boreholes in the communities; and household-based ceramic filters for the purification of water at home.

The district municipalities have committed themselves to monitoring the water quality at the communal water stations and to support their maintenance and operation. It is anticipated that the success of this pilot project could be replicated in other remote, rural areas in South Africa.

Enterprise creation FOR DEVELOPMENT

02
PROJECT HIGHLIGHTS

Through its enterprise creation for development (ECD) activities, the CSIR identifies and uses science and technology solutions sourced internally and from other partners, to create and develop sustainable enterprises in South Africa.
These activities are in response to national imperatives such as the creation of decent employment through inclusive economic growth, poverty reduction and the development of vibrant, equitable and sustainable rural communities.

Currently, ECD projects in the agro-processing and green economy sectors are found throughout South Africa. Examples of projects in the green economy include waste management in North West and Gauteng. A number of feasibility studies have been undertaken, resulting in the current development of waste management enterprises. Waste tyre recycling and renewable energy are at the heart of other green economy projects. Various CSIR competences are drawn upon in this regard.

The featured article (overleaf) focuses on the pilot production of essential oils in two provinces, North West and Free State.

The cultivation of yarrow as part of the essential oil demonstration agronomy project in Brits, Northwest. Yarrow is one of 20 aromatic plant species cultivated on a fifteen-hectare site using organic farming practices. The site is equipped with modern agro-processing technologies, including a steam distillation facility, to produce the essential oils. The project is funded by the Department of Science and Technology to provide cultivation and production data in support of South Africa's essential oils sector.

LOCAL ESSENTIAL OILS FOR INTERNATIONAL MARKETS

Lemon balm is one of many aromatic plant species cultivated on the Brits site.

Product development at the CSIR includes studies on formulated products such as these liquid drops containing Pelargonium extract. Products can take the form of capsules, syrups, tea bags or lotions and creams.

Distillation of essential oil: the final step in capturing the sought-after aromatic properties of essential oil plants.

Sustainable essential oil production in poor rural areas

Despite ideal agronomic conditions, South Africa is not yet a significant participant in the global market for essential oils. Essential oils are high-value, low-volume botanical products extracted from the leaves, stems and flowers of aromatic plants by steam distillation. These products range in value from $50 to $2 000 per kilogram and are used in the fragrance-related industries.

With its unemployment figure hovering at 25%, South Africa needs to address job creation, poverty reduction, rural development and inclusive economic growth. Poor communities in underdeveloped, rural areas of the country are particularly affected by the harsh reality of unemployment and poverty.

Introducing the production of essential oils in rural areas with suitable agricultural growing conditions and abundant labour – often located outside traditional industry-sector boundaries – offers an ideal opportunity to create sustainable enterprises.

A winning recipe for local organically certified essential oils

The global market for essential oils produced under organic cultivation conditions is attractive and continues to grow in response to consumer needs. To take advantage of this opportunity, a pilot essential oil production facility has been established in Brits in the North West on behalf of the Department of Science and Technology (DST).

The Brits essential oil agro-processing project demonstrates the local cultivation of new crops selected on the basis of market potential, indicated by either existing trade or by scientifically validated beneficial properties. On first impression, 20 crop species create an impressive vegetal display of lush green on the fifteen-hectare site. Basil, lemon balm, yarrow, lemon grass, thyme and sage (to name a few of the species) grow in abundance.

IN BRIEF

The CSIR has implemented seven community-based essential oils enterprises in South Africa. Crops such as rose geranium, lavender and buchu are grown on approximately 200 hectares. Two organically certified demonstration essential oil projects in the North West and Free State have aromatic crop species planted on plots of 10 to 20 hectares.

By creating these agro-processing enterprises, the CSIR makes it possible for rural communities to produce and sell high-value essential oils internationally as ingredients to the fragrance-related industry. Benefits include decent employment through inclusive economic growth, as well as training of the relevant workforce.

However, these selected hybrids pack far more than a sweet-smelling punch: with higher oil-yielding properties, they have been acquired from as far afield as Bulgaria, the US, India, Spain and Morocco. These crops are cultivated under organic farming practices to promote sustainable agriculture and to ensure the resultant essential oils are of the highest possible quality. The site also has modern agricultural technologies, including a steam distillation facility, to produce the essential oils. To keep up with all the requirements of this agro-production operation, 70 people from the Brits community have been employed.

A complementary undertaking is the pilot production of *Rosa damascena* essential oil, which is also funded by the DST. This essential oil is a key component of high-value fine fragrances; it is distilled from the petals of *Rosa damascena*, originally cultivated in selected regions of Bulgaria. The essential oil produced under organic cultivation conditions is extremely valuable and carries an import tag of $10 000 per kilogram.

The crisp climate of the eastern Free State proved to be a good starting point for a production site. The team imported rooted cuttings and worked with a local nursery to produce planting material using bud grafts on commercial scale.

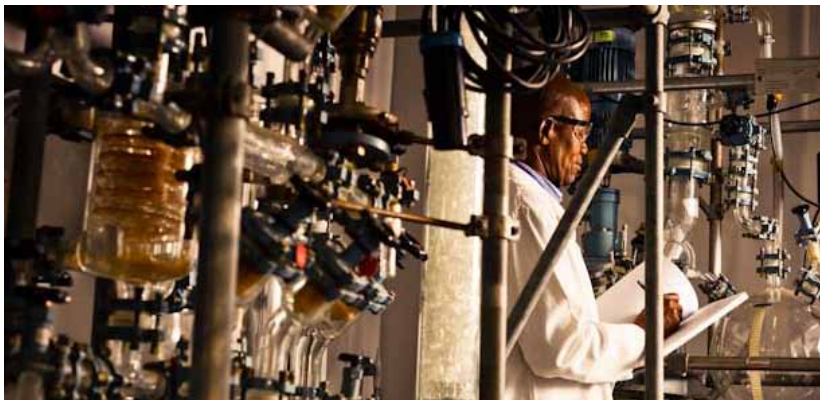
In its role as implementer, the CSIR is responsible for ensuring conformance to regulations and providing guidance on best practices in terms of cultivation and processing. Innovative agro-processing practices rely heavily on the expertise resident in different research groupings at the CSIR.

From planting to profits: the way forward

The production of new essential oils using organic farming practices at these two sites opens up a promising opportunity for South Africa's essential oils sector. Land preparation, installation of irrigation systems and training of local workers have created a hive of activity at the *Rosa damascena* site in the Free State. In Brits, workers have distilled essential oils from yarrow, lemon balm, marjoram, hyssop, sage and thyme crops; buyers are currently evaluating these oils.

The CSIR plays a vital role in gathering information on crop production techniques, distillation methods, quality assurance, sales and marketing to boost local production of these high-value, organically certified essential oils for international trade.

Local community members employed to support these projects stand to gain through their participation. Apart from the obvious advantages of the additional jobs created, basic agricultural training is continuously provided to the staff members by site managers. Skills development and technology transfer to resident communities hold the potential for future impact.



The processes used to produce and formulate botanical extracts from plants cultivated by communities, are optimised at bench-scale reactor facilities at the CSIR. Bench-scale reactors handle quantities of up to 30 litres, from where it can be further upscaled to pilot-scale. Factors that influence the quality of the extract include the extraction temperature or the ratio of solids to liquids. Results on improvement of the extracts are used by the product development and enterprise creation teams. Pictured above is the CSIR's William Mabotja.

Knowledge dissemination

03
KNOWLEDGE DISSEMINATION

For centuries, the communication chain for making research results accessible was very slow compared to today's standards. The past decade in particular has brought dramatic changes to the overall scientific communication process in terms of information distribution and retrieval. In addition, the international movement to disseminate research outcomes in open access forms of publication is gathering momentum.

The CSIR is well positioned to participate and contribute to the international open access initiative by making its research publications accessible through its institutional repository ResearchSpace **(http://researchspace.csir.co.za/dspace)**. From the download statistics reported below, it is clear that CSIR publications, accessible via ResearchSpace, are accessed extensively. On average 114 855 items are downloaded per month. That represents a download increase, on average, of 1 400 items per month since the 2010/11 financial year. CSIR ResearchSpace has also – during the year of review – increased its world ranking from 196 to 172 – the second highest in Africa; the first being University of Pretoria. ResearchSpace, launched in August 2007, remains the only open access, online repository by a South African research council.

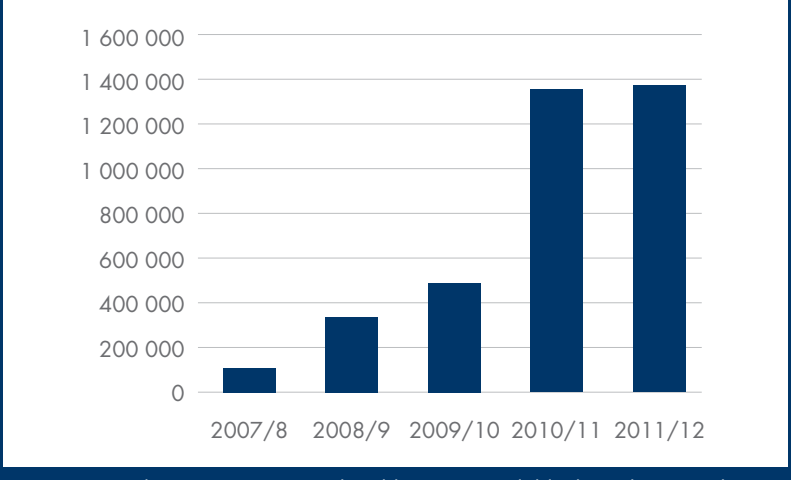


Figure 1: *Trend in access to research publications available through ResearchSpace*

The CSIR continues to place emphasis on the quality and quantity of research outputs, especially in scientific journals that undergo a rigorous peer-review process and have good citation indices. The number of articles published in accredited journals has shown a steady increase over the years and in the last year increased by 6%, from 297 in 2010/11 to 315 in 2011/12.

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New International Patents Granted

(Examining Countries): 34

- Aloesin (EPO in Nov 2011): Patent no: 1874751
- BP4 Asthma divisional (USA in Jan 2012): Patent no: 8,158,165
- BP4 Asthma (China - March 2012): Patent no: 200780015295.8
- BP 21 Erectile Dysfunction (Australia): Patent no: 2007/266668
- CaS process (Australia): Patent no: 2004/3299
- Dirfinder (Israel): Patent no: 181813
- Epoxides-Recombinant Yeast (Singapore): Patent no: WO 2005/100587
- Flagellin (EPO): Patent no: 1836221
- Fluoride removal (Australia): Patent no: 2007221951
- Hoodia-Pharmaceutical Compositions: France: Patent no: 1213020
- Hoodia-Pharmaceutical Compositions: Germany: Patent no: 1213020
- Hoodia-Pharmaceutical Compositions: Italy: Patent no: 1598054
- Hoodia-Pharmaceutical Compositions: Spain: Patent no: 1213020
- Hoodia-Pharmaceutical Compositions: UK: Patent no: 1756140
- Laser Ablation: Belgium: Patent no: 1985403
- Laser Ablation: Czech Republic: Patent no: 1985403
- Laser Ablation: Finland: Patent no: 1985403
- Laser Ablation: France: Patent no: 1985403
- Laser Ablation: Germany: Patent no: 1985403
- Laser Ablation: Great Britain: Patent no: 1985403
- Laser Ablation: Italy: Patent no: 1985403
- Laser Ablation: Netherlands: Patent no: 1985403
- Laser Ablation: Spain: Patent no: 1985403
- Laser Ablation: Sweden: Patent no: 1985403
- Laser Ablation: Switzerland: Patent no: 1985403
- Mineboot (Canada): Patent no: 2487435
- Nanoparticle Carriers for Drug Administration and Process for Producing same (EPO): 2249817
- Processing of a molten alloy (South Korea): Patent no: 10-1060743
- Processing of a molten alloy divisional 2 (USA): Patent no: 8,061,307
- Processing of a molten alloy divisional 3 (USA): Patent no: 7,921,900
- Safe Eggs (USA): Patent no: 8,071,146
- Spherezymes (Japan - Feb 2012): Patent no: 4931603
- Vir-Operon (USA): Patent no: 8143484
- Wheel and Track (Canada): Patent no: 2526740

Corporate governance

04
CORPORATE GOVERNANCE

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, accountability 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 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 (No 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. 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) (No 1 of 1999), as amended by Act 29 of 1999.

The CSIR Board and the CSIR Executive Management Committee believe that the organisation has complied with the major principles incorporated in the Code of Corporate Practices and Conduct, as set out in the King Report.

Shareholder's Compact

In terms of 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. These are included in the shareholder's performance agreement (Shareholder's 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. The chairperson of the Board and the Executive Management Committee hold bilateral meetings with the Executive Authority.

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. 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-audit work to be performed.

Risk management

The CSIR Board is accountable for the process of risk management which is 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 and is satisfied that the risk management process is effective.

Risk management in the CSIR is an ongoing process, focused on identifying, assessing, managing and monitoring all known forms of significant risks across all operations and Group companies. This has been in place for the year under review and up to the date of approval of the Annual 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 and maintained.

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, information systems, fraud, environmental management, occupational health and safety, operating and financial 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, and to ensure complete, timely and relevant reporting by management.

Based on the work of internal audit and the organisational results achieved, the Board is satisfied that the system of risk management has been effective during the year under review.

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. In order to mitigate research-related risks, the CSIR has an established Good Research Guide, research ethics 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).

The CSIR has established a Research Ethics Committee which is accountable to the Strategic Review Committee of the Board. The Committee reviews all projects which require evaluation from a research ethics perspective.

Business risk management

The organisation has effective mechanisms 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 areas such as human capital assessment and development, technological development and business continuity.

Information systems management

The group recognises that information and information systems are fundamental to effective, efficient and economical business processes. It is therefore essential that these resources are adequately managed and deployed.

Fraud risk management

The objective is to manage the fraud risk and to raise the level of fraud awareness among the CSIR's internal and external stakeholders. The CSIR's fraud prevention plan intends to reduce the risk of fraud and protect the interests of the organisation. The proactive approach consists of responsibility, prevention, detection, reporting, communication and reaction to fraud. All instances of financial misconduct are treated in accordance with the CSIR disciplinary code.

Environmental management, occupational health and safety

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 environment 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 practices 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 results areas (KRAs). The Operations Committee, which comprises members of the executive, operating unit and centre executive directors and group managers, oversees 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 an 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. The requisite skills and qualifications are in place for the management of the finance function.

Going concern

The CSIR Board has reviewed the Group's financial budgets for the period 1 April 2012 to 31 March 2013 and is satisfied that adequate resources exist to continue as a going concern for the foreseeable future. The CSIR Board confirms that it has assessed key sustainability risks and there is no reason to believe the business will not be a going concern in the year ahead.

The income streams of the CSIR are detailed in the notes to the financial statements.

Internal control

The CSIR Board has ultimate responsibility for the system of internal controls. The key controls required to mitigate risk and ensure the integrity and reliability of financial statements have been identified in conjunction with the internal and external auditors. Close cooperation between the internal and external auditors ensures adequate and efficient audit reviews of the proper functioning of these key controls.

The annual audit plan is based on the key risks to the organisation and the results of the risk management process. The work programme that gives effect to the plan is reviewed by the Audit and Risk Committee and approved or modified as required.

Internal financial controls have been assessed as effective to mitigate related risks.

Approval framework and policies

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; intellectual property management and investment in and disposal of property, plant and equipment. 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.

All subsidiary companies are under the control of a duly appointed Board of directors.

The Board reserves to itself all matters with potential to have material impact on the operations and reputation of the CSIR.

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 staff sessions; formal induction programmes; road shows; technical and strategic focus groups and task teams.

Code of business ethics and organisational values

The CSIR Board and CSIR Executive Management Committee have approved and adopted a code of ethics, which reflects its commitment to a policy of fair dealing and integrity in conducting its operations. The code aligns closely to the CSIR's set of values, compliance to laws and regulations and requires all employees to maintain the highest ethical standards, ensuring that business practices are conducted in a manner which is beyond reproach. Monitoring ethical behaviour is devolved to operating unit level and transgressions are addressed by means of procedures detailed in the CSIR's Conditions of Service and the PFMA.

Governance structure

The CSIR Board

The responsibilities of the Board are governed by the Scientific Research Council Act and the PFMA. 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. All non-executive Board members have been assessed as independent during the year under review.

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 30 June 2011, 15 September 2011, 31 October 2011 (strategy session), 17 November 2011 and 17 February 2012. The Annual Financial Statements for the 2011/12 financial year were approved on 28 June 2012.

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 pages 112 to 113). These committees are selected according to the skills sets required for the committees to fulfil their functions. For the 2011/12 year, the committees complied with their respective terms of reference.

The CSIR Board has adopted formal Terms of Reference reflected in the Board charter, which are annexed in the Shareholder's Compact. For the year under review, the Board has assessed its performance and that of its Committees. There are no issues of concern in this regard.

CSIR Board Members

The term of the Board appointed on 1 January 2009 came to an end on 31 December 2011. A new Board was appointed with effect from 1 January 2012.

Schedule of attendance of the CSIR Board and CSIR Board Committee meetings
(1 April 2011 to 31 December 2011)

Board member	Board meetings (4)	Audit and Risk committee (3)	Human Resources and Remuneration committee (2)	Strategic Review committee (2)
Petersen	4			2
Behrens	3			2
Benadè	4	3		1•
Knott-Craig	4		2	
Sibanda	4	3	1	1•
Silinga	3	1		
Thoka	3		2	
Wingfield	3			2
Sibisi	4	3[a]		2

a Attends in capacity as CEO
• Attendance as per invitation

Schedule of attendance of the CSIR Board and CSIR Committee meetings
(1 January 2012 to 31 March 2012)

Board member	Board meetings (1)	Audit and Risk committee (1)
Petersen	1	
Badela	1	*
Benadè	1	1
Cloete	1	
Goyns	1	
Mabitje-Thompson	1	
Nyokong	1	
Sibanda	1	1
Sibisi	1	1[a]
Tshabalala	1	*
Wingfield	1	

a Attends in capacity as CEO
* New Board members appointed to the Committee on 17 February 2012 (after date of meeting)

CSIR Board Members

1 April 2011 – 31 December 2011

Professor Francis Petersen (Chair)

Dean: Faculty of Engineering and the Built Environment, University of Cape Town

Mr Phillip Benadè

Retired

Mr Pepi Silinga

Chief Executive Officer: COEGA Development Corporation

Mr Norbert Behrens

Group General Manager: Strategy and Planning, Sasol Limited

Professor Mike Wingfield

Director Forestry and Agricultural Biotechnology Institute: University of Pretoria

Mr Mclean Sibanda

Head of Innovation Fund IP Management Office

Ms Khomotso Thoka

Managing Executive: The Talent Hub

Mr Alan Knott-Craig

Director of Companies

Dr Sibusiso Sibisi

CSIR CEO

1 January 2012 – 31 March 2012

The new CSIR Board pictured with the Minister of Science and Technology, Mrs Naledi Pandor (middle, front row), at the Board meeting on 17 February 2012.

New Board members are (back row from left): Dr Philip Goyns, Mr Phillip Benadè, Mr Ghandi Badela, Ms Swazi Tshabalala, Ms Malebo Mabitje-Thompson and Professor Mike Wingfield.

Front row from left: Dr Sibusiso Sibisi, Professor Francis Petersen, Professor Tebello Nyokong and Professor Eugene Cloete.

Executive Management Committee

The Executive Management Committee has executive responsibility for the CSIR and consists of the following members:

- CEO: Dr Sibusiso Sibisi
- Group Executive, Operations: Dr Hoffie Maree
- Group Executive, Research and Development: Dr Thulani Dlamini (resigned on 31 December 2011; Dr Molefi Motuku was appointed in this position on 1 June 2012)
- Group Executive, Strategic Alliances and Communication: Dr Rachel Chikwamba (appointed 1 March 2012)
- Chief Financial Officer: Mr Chris Sturdy
- Group Executive, Shared Services: Mr Raynold Zondo

All Executives are employed on a five-year contract basis.

CSIR Executive team, back row from left: Dr Hoffie Maree, Mr Raynold Zondo, Mr Chris Sturdy, Dr Molefi Motuku. Seated: Dr Sibusiso Sibisi and Dr Rachel Chikwamba.

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 and operating unit executive directors and centre managers.

Other internal structures that contribute to governance at the CSIR include the Executive, Operations and Strategic committees, the Strategic Research and Contract Research & Development forums, and the Research Advisory Panels.

Board of Directors and group companies

The CSIR Executive appoints the boards of the various subsidiary companies.

Board and Executive Management remuneration

Details of the CSIR Board are set out on pages 108 and 109 of the Corporate Governance Report. The membership and Terms of Reference of each Board Committee are further described on pages 112 to 113.

Remuneration of Board members and the Executive Management is set out in Note 19 of the Annual Financial Statements.

Remuneration of Executive Management is in accordance with the remuneration policy which has been approved by the CSIR Board.

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.

We shall continue to comply with all major recommendations of the Code of Corporate Practices and Conduct as set out in the King Report on Corporate Governance.

Public Finance Management Act (PFMA)

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 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 52 of the PFMA, has been finalised and incorporated into the Shareholder's Compact. No material losses through criminal conduct and irregular, fruitless and wasteful expenditure were identified as having been incurred during the year.

CSIR Board Committees (2011/12)

Audit and Risk Committee

April 2011 to December 2011

Chairperson Mr P Benadè

Members Mr M Silinga
Mr M Sibanda

Meetings 30 June 2011
25 August 2011
10 November 2011

January 2012 to March 2012

Chairperson Mr P Benadè

Members Mr M Sibanda
Ms BS Tshabalala
Mr G Badela

Meetings 9 February 2012

Purpose

- To deal with all matters prescribed by the regulations issued in terms of the PFMA and the King report on Corporate Governance;
- To perform the final review of the key risk matters affecting the organisation;
- To agree on the scope and review the annual external audit plan and the work of the CSIR internal auditors (including the internal audit charter); and
- To act 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

April 2011 to December 2011

Chairperson Mr ADC Knott-Craig

Members Ms KL Thoka
Mr M Sibanda

Meetings 30 June 2011
15 September 2011

January 2012 to March 2012

Chairperson Mr M Sibanda

Members Dr PH Goyns
Ms MSM Mabitje-Thompson

Purpose

- To provide a vehicle for the CSIR Board to influence and control human resources and remuneration in the organisation;
- To determine human resources policy and strategy and review remuneration against industry benchmarks; and
- To approve remuneration changes and bonus payments; in addition, it reviews the remuneration of the Executive Management.

The Human Resources and Remuneration 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.

Strategic Review Committee

April 2011 to December 2011

Chairperson	Prof FW Petersen
Members	Prof MJ Wingfield
	Mr N Behrens
	Dr SP Sibisi
Meetings	9 June 2011
	5 October 2011

January 2012 to March 2012

Chairperson	Prof FW Petersen
Members	Prof TE Cloete
	Prof TA Nyokong
	Prof MJ Wingfield
	Ms BS Tshabalala
	Mr G Badela
	Dr SP Sibisi

Invitation to Strategic Review Committee meetings is open to all Board members.

Purpose

- To provide 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; and
- To ensure 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.

The Strategic Review 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.

Board and Committee meeting attendance (1 April 2011 to 31 December 2011)

Board meetings

Date of Meeting	30/06/11	15/09/11	31/10/11	17/11/11
Petersen	Present	Present	Present	Present
Behrens	Present	Present	Present	Apology
Benadè	Present	Present	Present	Present
Knott-Craig	Present	Present	Present	Present
Sibanda	Present	Present	Present	Present
Silinga	Apology	Present	Present	Present
Thoka	Present	Present	Apology	Present
Wingfield	Present	Present	Present	Apology
Sibisi	Present	Present	Present	Present

Audit and Risk Committee meetings

Date of Meeting	30/06/11	25/08/11	10/11/11
Benadè	Present	Present	Present
Silinga	Apology	Present	Apology
Sibanda	Present	Present	Present

Human Resources and Remuneration Committee meetings

Date of Meeting	30/06/11	15/09/11	10/11/11
Knott-Craig	Present	Present	Present
Sibanda	Present	Apology	Apology
Thoka	Present	Present	Present

Strategic Review Committee meetings

Date of Meeting	09/06/11	05/10/11
Petersen	Present	Present
Behrens	Present	Present
Wingfield	Present	Present
Sibisi	Present	Present
Benadè*	Present	–
Sibanda*	–	Present

*Attendance by invitation

Board and Committee meeting attendance (1 January 2012 to 31 March 2012)

Board meetings

Date of Meeting	17/02/12
Petersen	Present
Badela	Present
Benadè	Present
Cloete	Present
Goyns	Present
Mabitje-Thompson	Present
Nyokong	Present
Sibanda	Present
Sibisi	Present
Tshabalala	Present
Wingfield	Present

Audit and Risk Committee meetings

Date of Meeting	09/02/12
Benadè	Present
Sibanda	Present
Tshabalala*	
Badela*	

*New Board members appointed to the Committee on 17 February 2012

Report of the Audit and Risk Committee

Year ended 31 March 2012

Report of the Audit Committee as required by Treasury Regulations 27.1.7 and 27.1.10 and S(51) (1)(a)(ii) of the Public Finance Management Act (No 1 of 1999), as amended by Act 29 of 1999.

The committee is pleased to present its report for the financial year ended 31 March 2012.

Committee members and attendance

The committee consists of the members as stated on page 112 of this report. In accordance with its approved Terms of Reference, the committee met four times during the year under review (i.e. 30 June 2011, 25 August 2011, 10 November 2011 and 09 February 2012). Schedule of attendance is shown on pages 114 and 115 of this report.

The committee's responsibility

The committee has adopted formal Terms of Reference in its charter in line with the requirements of Section 51(1)(a) of the PFMA and Treasury Regulations 27.1.7 and 27.1.10 and has discharged all of its responsibilities for the year, in compliance with the charter.

The effectiveness of internal control

Through the review of the internal audit activity and the results of the external audit, the committee is satisfied that an adequate system of internal control is in place to mitigate risks to an acceptable level. 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.

Internal audit

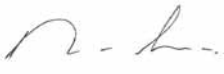
The committee has evaluated the internal control environment and based on the information provided has assessed the internal controls as effective to mitigate related risks.

Risk management

The committee is satisfied that the CSIR has an ongoing risk management process, focused on identifying, assessing, managing and monitoring all known forms of significant risks across all operations and Group companies. This has been in place for the year under review and up to the date of approval of the Annual Financial Statements.

Evaluation of Financial Statements

The committee has evaluated the Annual Financial Statements of the CSIR Group for the year ended 31 March 2012, and based on the information provided, the Audit and Risk committee considers that it complies, in all material respects with the requirements of the various Acts governing disclosure and reporting on the Annual Financial Statements. The committee therefore recommends the adoption of the Annual Financial Statements and the associated reports by the CSIR Board.



Phillip Benadè
Chairperson of the Audit and Risk Committee
28 June 2012

Report of the Auditor-General

Year ended 31 March 2012

Report of the Auditor-General to Parliament on the Council for Scientific and Industrial Research

Report on the Consolidated Financial Statements

Introduction

I have audited the consolidated and separate financial statements of the Council for Scientific and Industrial Research and its subsidiaries set out on pages 136 to 179, which comprise the consolidated and separate statement of financial position as at 31 March 2012, consolidated and separate statement of comprehensive income, statement of changes in equity and the statement of cash flows for the year then ended, and the notes, comprising a summary of significant accounting policies and other explanatory information.

Accounting Authority's responsibility for the consolidated and separate financial statements

The board of directors which constitutes the accounting authority is responsible for the preparation and fair presentation of these consolidated and separate financial statements in accordance with South African Statements of Generally Accepted Accounting Practice and the requirements of the Public Finance Management Act of South Africa, 1999 (Act No.1 of 1999) (PFMA), and for such internal control as the accounting authority determines is necessary to enable the preparation of consolidated and separate financial statements that are free from material misstatement, whether due to fraud or error.

Auditor-General's responsibility

My responsibility is to express an opinion on these consolidated and separate financial statements based on my audit. I conducted my audit in accordance with the Public Audit Act of South Africa, 2004 (Act No. 25 of 2004) (PAA), the *General Notice* issued in terms thereof and International Standards on Auditing. Those standards require that I comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the consolidated and separate financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the consolidated and separate financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the consolidated and separate financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the council's preparation and fair presentation of the consolidated and separate 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 council's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of the consolidated and separate financial statements.

I believe that the audit evidence I have obtained is sufficient and appropriate to provide a basis for my audit opinion.

Opinion

In my opinion, the consolidated and separate financial statements present fairly, in all material respects, the financial position of the Council for Scientific and Industrial Research and its subsidiaries as at 31 March 2012, and their financial performance and cash flows for the year then ended in accordance with South African Statements of Generally Accepted Accounting Practice and the requirements of the PFMA.

Report on other legal and regulatory requirements

PAA requirements

In accordance with the PAA and the *General Notice* issued in terms thereof, I report the following findings relevant to performance against predetermined objectives, compliance with laws and regulations and internal control, but not for the purpose of expressing an opinion.

Predetermined objectives

I performed procedures to obtain evidence about the usefulness and reliability of the performance information in the annual performance report as set out on pages 126 to 130 of the annual report.

The reported performance against predetermined objectives was evaluated against the overall criteria of usefulness and reliability. The usefulness of the information included in the annual performance report relates to whether it is presented in accordance with the National Treasury annual reporting principles and whether the reported performance is consistent with the planned objectives. The usefulness of information further relates to whether indicators and targets are measurable (i.e. well defined, verifiable, specific, measurable and time bound) and relevant as required by the *National Treasury Framework for managing programme performance information.*

The reliability of the information in respect of the selected objectives is assessed to determine whether it adequately reflects the facts (i.e. whether it is valid, accurate and complete).

There were no material findings on the performance information included in the Executive report concerning the usefulness and reliability of the information.

Compliance with laws and regulations

I did not identify any instances of material non-compliance with specific matters in key applicable laws and regulations as set out in the *General Notice* issued in terms of the PAA.

Internal control

I did not identify any deficiencies in internal control which we considered sufficiently significant for inclusion in this report.

Other reports

Agreed-upon procedures

As requested by the council, the following engagements were conducted during the year under review:

- Agreed upon procedure engagement: Royal Danish Embassy (SAWEP project) for the period 1 April 2010 to 31 March 2011. The report was issued on 3 August 2011.
- Agreed upon procedure engagement: Royal Danish Embassy (Energy Efficiency in the housing sector in South Africa project) for the period 1 February 2010 to 31 August 2011. The report was issued on 20 Sept 2011.
- Agreed upon procedure engagement: Department of Trade and Industry (National Foundry Technology Network "NFTN" contract) for the period 1 April 2010 to 31 March 2011. The report was issued on 11 July 2011.

- Agreed upon procedure report: National Research Foundation (NRF grants and The Human Resources for Industry Programme (THRIP) grants) for the period 1 April 2010 to 31 March 2011. The report was issued on 20 July 2011.

Donor funding

As requested by the council, the following engagements were conducted during the year under review:

- Reasonable assurance engagement: European Commission (CIFOR project) for the period 1 October 2010 to 28 February 2012. The report was issued on 2 March 2012.
- Reasonable assurance engagement: European Communities (Pharmaplant project) for the period 1 February 2008 to 31 January 2009, 1 February 2009 to 31 July 2010 and 1 August 2010 to 31 October 2011. The report was issued on 18 January 2012.
- Reasonable assurance engagement: Commission of the European Communities (ANTI MAL project) for the period 1 December 2006 to 30 November 2007 and 1 December 2008 to 31 May 2011. The report was issued on 20 June 2011.
- Reasonable assurance engagement: Commission of the European Communities (NOVEL Q project) for the period 1 March 2010 to 28 February 2011. The report was issued on 3 August 2011.
- Reasonable assurance engagement: Commission of the European Communities (STEAP Project) for the period 1 April 2007 to 31 May 2010. The report was issued on 20 April 2011.

Auditor-General

Pretoria
9 July 2012

AUDITOR-GENERAL SOUTH AFRICA
Auditing to build public confidence

Executive report

05
EXECUTIVE REPORT

Executive report

Introduction

On behalf of the CSIR Board, we take 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 financial year ended 31 March 2012.

In the opinion of the CSIR Board, the financial statements fairly present the financial position of the CSIR Group as at 31 March 2012 and the results of its operations for the year then ended.

Statutory basis

As a statutory research council established by government, the CSIR is governed by the Scientific Research Council Act (No 46 of 1988). The organisation is listed as a Public Business Enterprise in terms of the PFMA (No 1 of 1999).

The CSIR mandate

The CSIR's mandate is as stipulated in the Scientific Research Council Act (No 46 of 1988):
"The objects of the CSIR are, through directed and particularly multidisciplinary 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 cooperation 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." ~ Extract from Scientific Research Council Act (No 46 of 1988)

Income sources

The CSIR derives income from baseline and ring-fenced grants from the Department of Science and Technology (DST); contract research and development (R&D) income from local and international public and private sectors; and income from intellectual property (IP) exploits and technology transfer efforts.

Grant funding is invested in research programmes and research infrastructure as well as R&D skills development. Processes, policies and guidelines underpin the effective utilisation of grant funding.

Role in the National System of Innovation (NSI)

The CSIR plays a particular role in the innovation value chain within the National System of Innovation (NSI) as shown in **Figure 1**. The CSIR focuses on strategic basic and directed research, technology development, and technology transfer and implementation for commercial and social benefit. Limited fundamental research is undertaken to create new knowledge in selected areas.

To fulfil its mandate, the CSIR addresses priority issues that contribute to the national programme of development for the benefit of all South Africans. The CSIR strategic response to national imperatives is the development of the CSIR Growth and Impact Strategy, which is informed by external environmental drivers including:

- The Millennium Development Goals, and the 2015 targets which dictate agendas worldwide;
- The New Growth Path approved by Cabinet in 2010;
- The 12 South African national outcomes identified by Cabinet in 2010; and
- The National Development Plan released in November 2011.

In mapping the potential response to these external drivers, the CSIR identified potential areas of intervention that are in line with the CSIR mandate and that build on current organisational competencies and capabilities. The response to these drivers will build on, and continue with, the current CSIR responses to the DST Ten-Year Innovation Plan and the Department of Trade and Industry Industrial Policy Action Plan (IPAP2).

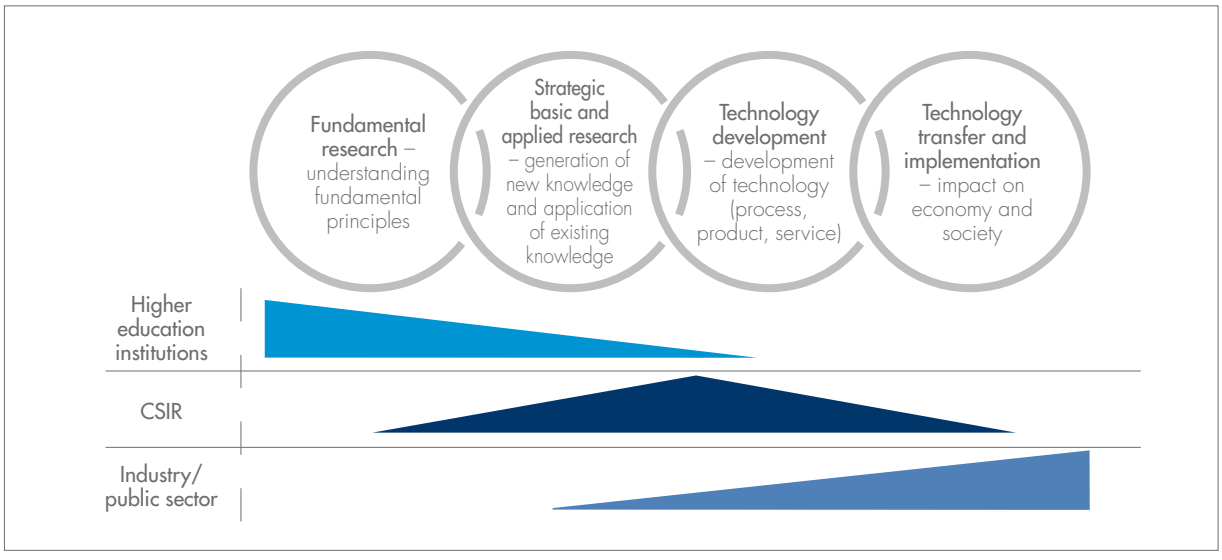


Figure 1: *The CSIR's role within the National System of Innovation (NSI)*

CSIR partnerships

The CSIR supports State-Owned Enterprises (SOEs) in the implementation of government strategies. In 2010, the CSIR signed a memorandum of agreement (MoA) with Eskom to collaborate on R&D in areas of mutual interest and in the national interest. Eight areas of collaboration have been identified and project plans are being developed.

The CSIR has undertaken substantial projects for Transnet, and is engaging with this organisation to establish a more strategic relationship. A memorandum of understanding (MoU) between the two organisations is in progress.

The CSIR signed an MoU with the State Information Technology Agency (SITA) in June 2011. The MoU commits the organisations to collaboration in the national interest on applications and research in the fields of information and communications technology (ICT); space technologies; services such as health care; and spatial technologies.

The relationship with the Development Bank of Southern Africa (DBSA) is growing, with increasing collaboration on rural service delivery.

The CSIR has a long history of relevance to the South African private sector, and is looking to reinforce this role in the implementation of the Growth and Impact Strategy. The relationship with the private sector is being enhanced through development of sector-based value propositions aimed at increasing partnering and collaboration, focusing on aerospace, automotive, mining, textiles, defence, forestry, health and built environment sectors.

In March 2012, the CSIR established a research partnership with Nestlé focusing on evaluating the potential of indigenous South African biodiversity for nutraceutical and functional foods with proven health benefits.

There is a process of engaging with Sasol at a strategic level. The process has identified environmental research (mine water treatment, air pollution and waste) and energy (concentrated solar power) as areas of mutual interest.

Strategic engagements with Aerosud and DuPont are underway to establish more formal relationships.

The CSIR has developed an Africa strategy that aims to contribute to Africa's development. Implementation of the strategy builds on current CSIR activities in Africa such as infrastructure development, ICT development, environmental issues, human capital development (HCD) and support to peace-keeping missions.

The CSIR has an MoU with the Uganda Industrial Research Institute (UIRI), with an emphasis on assisting UIRI in business incubation in the agro-processing sector, and HCD.

The CSIR's strategic partnership with South African higher education institutions (HEIs) is a key component of its HCD and R&D strategies. Currently, the CSIR has memoranda of agreement on research collaboration with 11 HEIs in South Africa, namely the University of Cape Town; Stellenbosch University; University of Johannesburg; University of the Witwatersrand; University of Pretoria; Tshwane University of Technology; Walter Sisulu University; Nelson Mandela Metropolitan University; University of Fort Hare; University of Limpopo; and University of Western Cape. Particular attention is paid to developing partnerships with previously disadvantaged HEIs. New agreements are being developed with the Universities of Free State and Venda.

The partnerships with HEIs will be further developed to support the CSIR Growth and Impact Strategy.

Overview of 2011/12 performance

The CSIR performed very well in attaining the objectives set in its annual Strategic and Operational Plan, and exceeded some targets that were expected to be affected by the ongoing economic climate. Once again, the organisation has demonstrated high standards of science, financial sustainability and corporate governance.

The CSIR has delivered positive financial results, with total turnover continuing to grow, and the net margin exceeding target, despite the transfer of the Satellite Application Centre (with revenue of R85.6 million) to the South African National Space Agency on 1 April 2011. The target for private sector and international income was exceeded, reflecting the desired diversification of the CSIR funding sources. The value of capital investment in scientific equipment and facilities was in excess of the target as a consequence of additional funding secured to purchase equipment. The CSIR made an impressive investment of R184.2 million. The CSIR maintained a customer satisfaction index better than 80%.

Attraction and retention of suitably qualified and capable staff remains an ongoing challenge. However, the CSIR's approach to HCD and human resource management ensured that the relevant targets were exceeded, with the exception of the number of staff with doctorates. The HCD pipeline was expected to be relatively modest owing to the economic climate, but these targets were all exceeded. Similarly, strategic research alliance performance exceeded expectations. Research outputs in terms of publication equivalents increased considerably.

The CSIR's electricity utilisation was reduced by 1.3% from the previous year. The target of a level 3 Broad-Based Black Economic Empowerment (B-BBEE) contributor was achieved. A renewed focus on employee safety has improved the injury index substantially, and the annualised injury frequency rate has been zero for much of the year.

The CSIR has maintained its record with an unqualified audit report.

Setting of KPIs and performance reporting

The CSIR enters into a Shareholder's Compact Agreement annually with the DST. The compact comprises a rolling three-year strategic plan and an operational plan with very specific key performance indicators (KPIs). Strategic planning in the CSIR is supported by ongoing benchmarking against similar research organisations, and trend analysis of KPIs. Quarterly reports and the annual Science, Engineering and Technology Institution (SETI) scorecard report to the DST address performance in terms of KPIs. The CSIR has a proud record of attaining KPI targets over the past few years.

Organisational priorities

The CSIR's strategy is translated into organisational priorities as the framework for the annual operational plan. Organisational priorities have remained consistent over the past few years and are reflected in **Figure 2**.

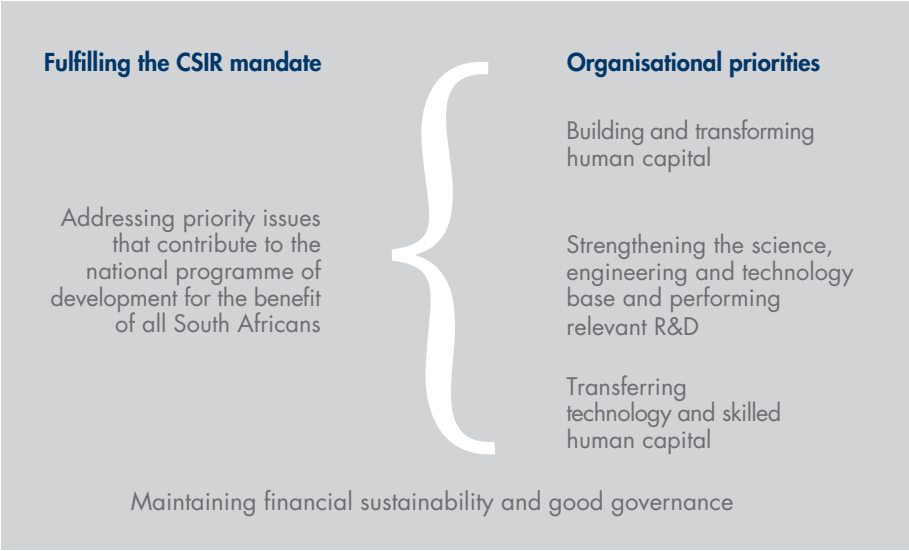


Figure 2: *Organisational priorities*

Portfolio offices exist to coordinate and support strategic priorities such as those of Human Capital Development; Licensing and Ventures; Strategic Alliances and Communication; and Strategic Initiatives Implementation. Organisational support units form a CSIR Shared Services grouping and render transactional or specialist strategic support and administrative services to the rest of the organisation.

Priority area: Building and transforming human capital

HCD is essential to achieving the CSIR's strategic goals. The new CSIR Growth and Impact Strategy places a large emphasis on fewer large technology development programmes to achieve greater impact and this will introduce another dynamic to the competency framework of the organisation. HCD remains essential to organisational success, and is being achieved in line with the CSIR Human Resources (HR) strategy.

Table 1: *Building and transforming human capital*

Strategic focus area	Key performance indicator	2011/12 target	2011/12 actual
Human capital development	Number of permanent CSIR staff studying towards Master's and PhD degrees	170	245
	Number of studentships supported	180	245
	Number of bursars appointed	90	145
Human resource management	Total size of SET base (Number, %)	1 530 (64.0%)	1 537 (64.9%)
	% of SET base who are black	53.0	54.4
	% of SET base who are female	33.0	34.5
	Number of staff with PhD level qualifications	300	293

Priority area: Strengthening the SET base and performing relevant R&D

The CSIR Growth and Impact Strategy is structured around Research Impact Areas (RIAs) that have been under development in the last year and flagship programmes.

The six RIAs forming the building blocks of the Growth and Impact Strategy are: Energy; Industry; Built Environment; Natural Environment; Defence and Security; and Health. The RIAs are supported by key cross-cutting enabling technologies (see **Figure 3**).

Figure 3: *CSIR research impact areas and enabling technologies and facilities*

The RIA strategies continue to mature, informed by stakeholder engagement. The current strategic intent and focus of each RIA is summarised in **Table 2**, but will be subject to ongoing development.

Table 2: *Portfolio of CSIR Research impact areas*

Research impact area		Key focus areas
Health		• Health care delivery system • Burden of diseases: HIV, TB and malaria • Point-of-care diagnostics
Energy		• Renewable and alternative energy (under development)
Defence and security		• Information security • Interoperability and standardisation across organs of state tasked with defence and security • Command, control and coordination • Tactical and strategic situation awareness
Built environment		• Planning support systems • Logistics and infrastructure operations • Sustainable human settlements • Water infrastructure • Transport infrastructure
Natural environment		• Support for decision-making and resource planning • Assessing and monitoring the state of the natural environment • Technologies for water, pollution and waste solutions
Industry	Advanced manufacturing	• Advanced materials and composites for industry • Advanced metals industry with a focus on Titanium • Bio-manufacturing industry • Additive manufacturing • Microsystems and micro-manufacturing • Facilities for the development of High Tech Products
	Mining	• Health and safety • New mining methods • Decision support systems

Flagship programmes, which cut across RIAs, are being developed. They will be large, integrated, impact-driven development and innovation initiatives. They will have clear objectives and intended outcomes, with objectives that can be achieved within a set time. They will be funded initially by the Parliamentary Grant (PG), but partnering with stakeholders to leverage resources and funding will be key in pursuing the goals of the programmes. They will draw on capabilities developed in the RIAs.

The CSIR has selected three flagship programmes:

- Water sustainability;
- Health and nutrition; and
- Safety and security.

The CSIR achieved outstanding performance with regard to its objective of strengthening the SET base, when measured against targets set for its key performance indicators, see **Table 3**. Significant progress was made with both the quality and quantity of research outputs. The success in this area was supported by numerous active and successful research partnerships.

Table 3: *Strengthening the SET base and performing relevant R&D*

Strategic focus area	Key performance indicator	2011/12 target	2011/12 actual
R&D outputs	Publication equivalents	490	529.5
	New technology demonstrator equivalents	25	37
Strategic research alliances	Value of collaborative R&D activities with a value exceeding R1.5 m	R140.0 m	R212.5 m
	Value and number of collaborative research projects with HEIs	R101.0 m 86	R140.5 m 86

Research productivity

The CSIR continues to place emphasis on the quality and quantity of research outputs, especially in scientific journals that undergo a rigorous peer-review process and have good citation indices. The number of articles published in accredited journals has shown a steady increase over the years and in the last year increased by 6% – from 297 in 2010/11 to 315 in 2011/12.

Priority area: Transferring technology and skilled human capital

The CSIR R&D capacity provides value to society through the contract R&D it undertakes and through the commercialisation of formally protected IP, see **Table 4**.

Table 4: *Transferring technology and skilled human capital*

Strategic focus area	Key performance indicator	2011/12 target	2011/12 actual
R&D outcomes	New international patents granted	12	34
	Number of new technology packages available for transfer	19	31
	Royalty and licence revenue	R8.5 m	R10.2 m
Contract R&D	Contract R&D income	R1 118.1 m	R1 273.4 m
	Private sector and international income	R305.1 m	R320.4 m
	Customer satisfaction	80%	83.4%

Priority area: Financial sustainability, good corporate governance and citizenship

The CSIR continued to demonstrate its financial sustainability despite the global economic climate. Further details are provided in **Table 5**. The solid performance in achieving corporate governance and citizenship targets was maintained.

Table 5: *Financial sustainability, good corporate governance and citizenship*

Strategic focus area	Key performance indicator	2011/12 target	2011/12 actual
Financial sustainability	Value of investment in property, plant and equipment	R88.2 m	R184.2 m
	Total income	R1.67 billion	R1.88 billion
	Net profit	R34.1 m	R68.9 m
Corporate governance and citizenship	B-BBEE rating	Level 3 contributor	Level 3 contributor
	Energy efficiency	Achieve 1.2% reduction in energy consumption on previous year	Achieved 1.3% reduction in energy consumption on previous year
	Disabling injury frequency rate (DIFR)	<0.3	0.04

Financial performance overview

Income

The total operating income of the CSIR increased by 9.1% to an amount of R1 881 million (2010/11: R1 723.6 million). The CSIR Group's total operating income amounted to R1 877.7 million (2010/11: R1 735.7 million).

The Parliamentary Grant recognised as income in 2011/12 amounted to R556.8 million, an increase of 4% from the prior year's amount of R535.3 million.

The CSIR's total contract R&D income increased by 8.4% to R1 273.4 million (2010/11: R1 175.1 million). This includes R55.4 million (2010/11: R64.9 million) ring-fenced funding from the DST. The CSIR Group's total contract R&D income increased to an amount of R1 270 million (2010/11: R1 187.2 million).

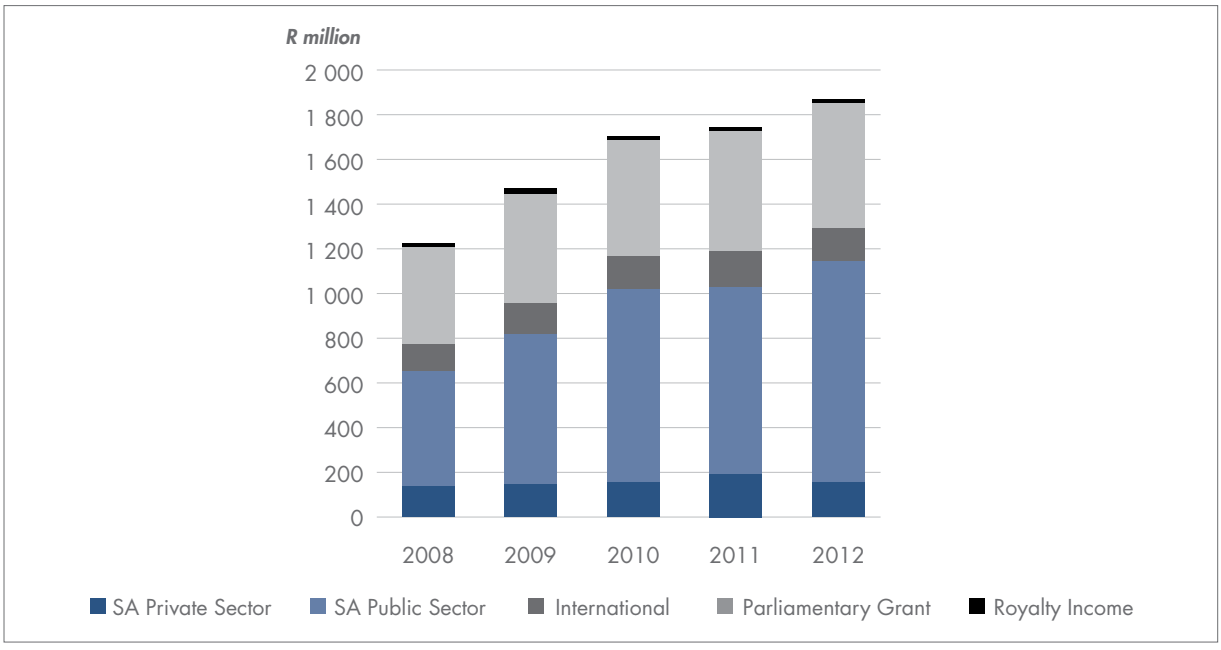


Figure 4: *CSIR income streams for financial years ending 2008–2012*

The CSIR's continued alignment with national strategic priorities ensured that a significant part of the contract income was received from the South African public sector, amounting to R952.9 million (2010/11: R820.7 million). The transfer of the Satellite Application Centre to the South African National Space Agency resulted in a decrease in public and international sector income from 2010/11.

Income from the South African private sector amounted to R181.1 million (2010/11: R193.3 million).

International contract income was additionally affected by the slow economic growth in international markets. Contract income from the international sector amounted to R139.3 million (2010/11: R161 million).

The continued investment in scientific infrastructure and equipment remains a priority to ensure that world-class facilities and equipment are acquired and maintained. Over the past five financial years R756.2 million has been invested in property, plant and equipment.

Five-year review of income and expense indicators

	2012 R'000	2011 R'000	2010 R'000	2009 R'000	2008 R'000
Total income	**1 919 381**	**1 776 827**	**1 748 848**	**1 554 910**	**1 271 062**
Parliamentary Grant recognised as income	556 837	535 357	509 122	480 320	429 013
Contract income, royalty income, other income and net finance income	**1 362 544**	**1 241 470**	**1 239 726**	**1 074 590**	**842 049**
Local private sector	181 190	193 362	151 339	147 752	137 683
Local public sector	952 909	820 705	848 846	661 682	508 779
International sector (including Africa)	139 301	161 027	159 610	142 002	119 584
Royalties and other income	50 771	13 197	11 168	40 516	22 908
Net finance income	38 373	53 179	68 763	82 638	53 095
Total expenditure	**1 850 383**	**1 741 317**	**1 695 419**	**1 495 442**	**1 219 665**
Employees' remuneration	1 014 879	940 776	873 445	763 867	619 529
Operating expenses	793 680	759 048	779 832	694 435	572 454
Depreciation	41 824	41 493	42 142	37 140	27 682

Net profit and cash flow

The net profit of the CSIR amounts to R68.9 million (2010/11: R35.5 million). The net profit for the CSIR Group was R64.8 million (2010/11: R33.8 million). The increase in the net profit is partly attributable to the increase in foreign exchange gains and the transfer of property to the Department of Public Works.

Net cash from operating activities for the CSIR amounted to R78.5 million (2010/11: R299.1 million). The cash and cash equivalent holdings of the CSIR decreased to R949.3 million (2010/11: R975.7 million). The current ratio remains the same as the previous financial year at 1.1.

Five-year ratio analysis

	2012 R'000	2011 R'000	2010 R'000	2009 R'000	2008 R'000
Operating expenses					
Remuneration as a percentage of total income (excluding finance income)	**54.0%**	54.6%	52.0%	51.9%	50.9%
Remuneration as a percentage of total operating expenditure	**54.8%**	54.0%	51.5%	51.1%	50.8%
Asset management					
Investment in property, plant and equipment (Rm)	**184.2**	118.8	179.0	188.3	85.9
Investment in property, plant and equipment as a percentage of revenue	**10.0%**	6.9%	10.7%	13.0%	7.1%
Net asset turn	**3.3**	3.3	3.4	3.4	3.2
Current ratio	**1.1**	1.1	1.1	1.0	1.2
Cash flow					
Net cash from operating activities	**78 562**	299 171	25 967	285 546	167 307
Cash and cash equivalents at end of year	**949 360**	975 755	766 278	834 830	673 309

Definitions

Net asset turn: Total revenue (including finance income) divided by net assets

Current ratio: Current assets divided by current liabilities

The post-retirement medical benefit expense and liability and the effects of the adoption of SA GAAP, IAS39: Financial instruments – recognition and measurement have been excluded for the comparison of financial indicators.

Annual Financial Statements

06
ANNUAL FINANCIAL STATEMENTS

Statements of Comprehensive Income

for the year ended 31 March 2012

	Notes	GROUP 2012 R'000	GROUP 2011 R'000	CSIR 2012 R'000	CSIR 2011 R'000
Revenue	2	**1 837 126**	1 731 174	**1 840 481**	1 719 067
Other income		**40 632**	4 592	**40 527**	4 581
Total operating income		**1 877 758**	1 735 766	**1 881 008**	1 723 648
Expenditure					
Employees' remuneration		**1 015 735**	946 485	**1 014 879**	940 776
Depreciation and amortisation	6 & 7	**41 859**	42 067	**41 824**	41 493
Operating expenses		**793 403**	768 176	**793 680**	759 048
Total operating expenditure		**1 850 997**	1 756 728	**1 850 383**	1 741 317
Finance income	4	**44 028**	58 861	**42 792**	57 243
Finance expense	4	**(4 419)**	(4 063)	**(4 419)**	(4 063)
Share of (loss)/profit of joint ventures and associates	8	**(786)**	119	**–**	–
Profit before income tax	3	**65 584**	33 955	**68 998**	35 511
Income tax expense	5	**–**	(60)	**–**	–
Profit for the year		**65 584**	33 895	**68 998**	35 511
Other comprehensive income					
Foreign currency translation differences for foreign operations		**(763)**	(17)	**–**	–
Other comprehensive income for the year		**(763)**	(17)	**–**	–
Total comprehensive income for the year		**64 821**	33 878	**68 998**	35 511
Profit attributable to:					
Stakeholders of the parent		**65 584**	33 895	**68 998**	35 511
Total comprehensive income attributable to:					
Stakeholders of the parent		**64 821**	33 878	**68 998**	35 511

Statements of Financial Position

as at 31 March 2012

	Notes	GROUP 2012 R'000	GROUP 2011 R'000	CSIR 2012 R'000	CSIR 2011 R'000
ASSETS					
Non-current assets		**434 332**	394 317	**450 958**	419 677
Property, plant and equipment	6	**428 960**	392 480	**428 924**	392 105
Intangible assets	7	**–**	18	**–**	–
Interest in joint ventures and associates	8	**5 372**	1 419	**1 301**	1 376
Interest in subsidiaries	9	**–**	–	**20 733**	26 196
Deferred tax asset	13	**–**	400	**–**	–
Current assets		**1 215 846**	1 312 351	**1 195 911**	1 280 194
Trade and other receivables	11	**179 250**	118 509	**179 050**	123 631
Inventory and contracts in progress	12	**67 501**	89 549	**67 501**	85 918
Cash and cash equivalents	24	**969 095**	1 009 403	**949 360**	975 755
Non-current asset held for sale	6.1	**–**	94 890	**–**	94 890
TOTAL ASSETS		**1 650 178**	1 706 668	**1 646 869**	1 699 871
EQUITY AND LIABILITIES					
Reserves		**580 158**	541 030	**577 526**	534 221
Retained earnings		**580 158**	540 267	**577 526**	534 221
Non-distributable reserve: Foreign currency translation reserve		**–**	763	**–**	–
Non-current liabilities		**8 260**	10 142	**8 260**	10 142
Post-retirement medical benefits	18.4	**8 260**	10 142	**8 260**	10 142
Current liabilities		**1 061 760**	1 155 496	**1 061 083**	1 155 508
Advances received	14	**618 620**	628 626	**618 620**	628 626
Trade and other payables	15	**443 140**	526 542	**442 463**	526 882
Provisions	16	**–**	328	**–**	–
TOTAL EQUITY AND LIABILITIES		**1 650 178**	1 706 668	**1 646 869**	1 699 871

Statements of Changes in Equity

for the year ended 31 March 2012

	Retained earnings R'000	Non-distributable reserve* R'000	Total R'000
GROUP			
Balance at 31 March 2010	506 372	780	**507 152**
Total comprehensive income	33 895	(17)	**33 878**
Profit for the year	33 895	–	**33 895**
Other comprehensive income for the year:			
Foreign currency translation differences for foreign operations	–	(17)	**(17)**
Balance at 31 March 2011	**540 267**	**763**	**541 030**
Total comprehensive income	65 584	(763)	**64 821**
Profit for the year	65 584	–	**65 584**
Other comprehensive income for the year:			
Foreign currency translation differences for foreign operations	–	(763)	**(763)**
Transfer of the Satellite Application Centre (SAC)**	(25 693)	–	**(25 693)**
Balance at 31 March 2012	**580 158**	**–**	**580 158**
CSIR			
Balance at 31 March 2010	498 710	–	**498 710**
Total comprehensive income	35 511	–	**35 511**
Profit for the year	35 511	–	**35 511**
Balance at 31 March 2011	**534 221**	**–**	**534 221**
Total comprehensive income	68 998	–	**68 998**
Profit for the year	68 998	–	**68 998**
Transfer of the Satellite Application Centre (SAC)**	(25 693)	–	**(25 693)**
Balance at 31 March 2012	**577 526**	**–**	**577 526**

* 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. This reserve is nil as at 31 March 2012 due to the sale of Quotec Limited during the 2012 financial year. Refer to note 27.

** Refer to note 26.

Statements of Cash Flows

for the year ended 31 March 2012

	Notes	GROUP 2012 R'000	GROUP 2011 R'000	CSIR 2012 R'000	CSIR 2011 R'000
Cash flows from operating activities					
Cash receipts from external customers		**1 257 380**	1 210 338	**1 266 713**	1 189 047
Parliamentary Grant received		**549 111**	550 305	**549 111**	550 305
Cash paid to suppliers and employees		**(1 771 027)**	(1 514 002)	**(1 776 877)**	(1 493 360)
Cash generated from operating activities	23	**35 464**	246 641	**38 947**	245 992
Finance income received		**45 270**	58 861	**44 034**	57 243
Finance expense paid		**(4 419)**	(4 064)	**(4 419)**	(4 064)
Income taxes paid		**–**	(202)	**–**	–
Net cash from operating activities		**76 315**	301 236	**78 562**	299 171
Cash flows from investing activities					
Acquisition of property, plant and equipment	6	**(100 684)**	(90 450)	**(100 645)**	(90 311)
Proceeds on disposal of property, plant and equipment		**4 343**	654	**4 343**	397
Decrease in subsidiary loans		**–**	–	**500**	1 365
Increase in interest in joint ventures and associates		**(3 500)**	–	**–**	–
Disposal of interests in subsidiaries	27	**(7 179)**	–	**–**	–
Transfer of the Satellite Application Centre (SAC)	26	**(11 945)**	–	**(11 945)**	–
Acquisition of intangible assets	7	**(448)**	(858)	**–**	–
Net cash utilised in investing activities		**(119 413)**	(90 654)	**(107 747)**	(88 549)
Cash flows from financing activities					
Decrease in long-term liabilities		**(158)**	(642)	**(158)**	(642)
Net cash utilised in financing activities		**(158)**	(642)	**(158)**	(642)
Unrealised exchange gains/(losses) on foreign cash balances		**2 948**	(519)	**2 948**	(503)
Net (decrease)/increase in cash and cash equivalents		**(40 308)**	209 421	**(26 395)**	209 477
Cash and cash equivalents at beginning of the year		**1 009 403**	799 982	**975 755**	766 278
Cash and cash equivalents at end of the year	24	**969 095**	1 009 403	**949 360**	975 755

Notes to the Annual Financial Statements

for the year ended 31 March 2012

1 PRINCIPAL ACCOUNTING POLICIES

The CSIR is a national government business enterprise (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 CSIR undertakes 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.

The consolidated Annual Financial Statements of the Group as at and for the year ended 31 March 2012 comprise the company and its subsidiaries (together referred to as the Group) and the Group's interest in associates and jointly controlled entities.

Basis of measurement

The consolidated Annual Financial Statements are prepared on the historical cost basis except for financial instruments held for trading 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. Non-controlling interests are stated at the non-controlling interests' proportion of the fair values of the assets and liabilities recognised. All significant intercompany balances and transactions between group entities are eliminated on consolidation.

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.

Investments in subsidiaries are measured at cost less accumulated impairment losses in the CSIR's Annual Financial Statements.

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's share of the total recognised gains and losses of associates is incorporated in the

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Interest in associates (continued)

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.

Where a group enterprise transacts with an associate company, unrealised gains and losses are eliminated against the investment 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.

Investments in associates are measured at cost less accumulated impairment losses in the CSIR's Annual Financial Statements.

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.

The Group's share of the total recognised gains and losses of jointly-controlled entities is incorporated in the consolidated financial statements, from the date that joint control commences until the date that joint control 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.

Where a group enterprise transacts with a joint venture, unrealised gains and losses are eliminated against the investment 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. 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.

Investments in joint ventures are measured at cost less accumulated impairment losses in the CSIR's Annual Financial Statements.

Loss of control

On the loss of control, the Group derecognises the assets and liabilities of the subsidiary, and non-controlling interests and the other components of equity related to the subsidiary. Any surplus or deficit arising on the loss of control is recognised in profit or loss. If the Group retains any interest in the previous subsidiary, then such interest is measured at fair value at the date that control is lost. Subsequently it is accounted for as an equity-accounted investee or as an available-for-sale financial asset depending on the level of influence retained.

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 acquisition, at rates of exchange ruling at the reporting date.
- Revenue, expenditure and cash flow items at the average rates of exchange during the relevant financial year (the average rates approximate exchange rates at the various dates).

Differences arising on translation are recognised in other comprehensive income and presented in equity 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.

Notes to the Annual Financial Statements

for the year ended 31 March 2012

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Foreign operations (continued)

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 other comprehensive income and presented 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 translated into South African rand using the rates of exchange ruling at the reporting date. The resulting exchange differences are recognised in profit or loss. Non-monetary assets and liabilities measured at fair value are translated at foreign exchange rates ruling at the date the fair value was determined.

Property, plant and equipment

Owned assets

Land is stated at cost less accumulated impairment losses. Buildings, equipment and vehicles are stated at cost less accumulated depreciation and accumulated impairment losses. Cost includes expenditure directly attributable to acquisition.

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.

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. Land is not depreciated.

The estimated lives of the main categories of property, plant and equipment for the current and comparative period are as follows:

- Buildings: 40 years
- Equipment: 3 to 10 years
- Vehicles: 10 years

Depreciation methods, useful lives and current residual values, if not insignificant, are reassessed annually.

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

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Research and development (continued)

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.

Goodwill

Goodwill arising on the acquisition of subsidiaries, associates or joint ventures represents the excess of the cost of an acquisition over the fair value of the Group's interest in the net assets of the acquired subsidiary, associate or joint venture at the date of the acquisition (refer to basis of consolidation). 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 statement of financial position 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 of a subsidiary is negative (bargain purchase), it is recognised immediately 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

Amortisation methods, useful lives and residual values are reviewed at each reporting date and adjusted if appropriate.

Impairment

Financial assets

A financial asset not classified at fair value through profit or loss 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.

Individually-significant financial assets and those that have been identified as impaired 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.

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 the reversal is recognised in profit or loss.

Notes to the Annual Financial Statements

for the year ended 31 March 2012

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Non-financial assets

The carrying amounts of the Group's non-financial assets, other than 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 arising from the acquisition of subsidiaries 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 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. Once classified as held for sale, property, plant and equipment and intangible assets are no longer depreciated/amortised.

Short-term employee benefits

Short-term employee benefit obligations are measured on an undiscounted basis and are expensed as the related service is provided. A liability is recognised for the amount expected to be paid under short-term cash bonus if the Group has a present legal or constructive obligation to pay this amount as a result of past service provided by the employee, and the obligation can be estimated reliably.

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 profit or loss when due.

1 PRINCIPAL ACCOUNTING POLICIES (continued)

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 reporting 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 profit or loss on a systematic basis over the employees' working lives within the Group.

Actuarial gains and losses are recognised in full in profit or loss in the year when actuarially determined. The amount recognised in the statement of financial position represents the present value of the post-retirement medical aid contribution. 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

Inventory is measured at the lower of cost and net realisable value. Cost of inventory is determined by the weighted average method. In the case of work in progress, cost includes an appropriate share of production overheads based on normal operating capacity. 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, less progress billings.

Income tax

The CSIR is exempt from South African income tax. The income tax expense of subsidiary companies is reflected on Group level.

Income tax expense comprises current and deferred tax. The current tax charge 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 reporting date. Income tax expense is recognised in profit or loss except to the extent that it relates to items recognised directly in other comprehensive income or equity, in which case it is recognised in other comprehensive income or equity.

Deferred tax is recognised 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 is not recognised for the following temporary differences: the initial recognition of assets or liabilities in a transaction that is not a business combination and that affects neither profit or loss, and differences relating to investments in subsidiaries, associates and jointly controlled entities to the extent that it is probable that they will not reverse in the foreseeable future.

Deferred tax assets and liabilities are offset when there is a legally enforceable right and 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.

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

Notes to the Annual Financial Statements

for the year ended 31 March 2012

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Provisions (continued)

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 and 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 the reporting 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, 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 reporting 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.

Royalties are accrued based on the stipulations of the applicable contracts.

Finance income/expense

Finance income/expense comprises interest receivable on funds invested, dividend income, fair value adjustments on investments and interest payable on borrowings. Interest income is recognised in profit or loss as it accrues, using the effective interest rate method. Dividend income is recognised in profit or loss on the date that 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.

Expenses

Operating lease payments

Payments made under operating leases are recognised in profit or loss on a straight-line basis over the term of the lease. Lease incentives received are recognised in profit or loss as an integral part of the total lease expense, over the term of the lease.

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

1 PRINCIPAL ACCOUNTING POLICIES (continued)

Financial instruments (continued)

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.

Held-to-maturity financial assets

If the Group has the positive intent and ability to hold fixed deposits to maturity, then such financial assets are classified as held to maturity. Held-to-maturity financial assets are recognised initially at fair value plus any directly attributable transaction costs. Subsequent to initial recognition, held-to-maturity financial assets are measured at amortised cost using the effective interest method, less any impairment losses. Held-to-maturity financial assets comprise fixed deposits.

Loans and receivables

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.

Loans

Loans are measured at amortised cost using the effective interest method less any impairment losses if they have a fixed maturity, or at cost if there is no fixed maturity.

Cash and cash equivalents

Cash and cash equivalents are measured at amortised cost, which is their fair value. Cash and cash equivalents comprise bank balances, cash on deposit and cash on hand.

Financial assets at fair value through profit or loss

Forward exchange contracts

Forward exchange contracts are fair valued and gains and losses are recognised in profit or loss. Hedge accounting is not applied.

Financial liabilities at amortised cost

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.

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 profit or loss.

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 the amount paid for it is included in profit or loss.

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 the reporting 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.

Notes to the Annual Financial Statements

for the year ended 31 March 2012

1 PRINCIPAL ACCOUNTING POLICIES (continued)

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 2012, the following standards and interpretations were in issue but not yet effective:

Standard/Interpretation	Description	Effective Date
IFRS 1 amendment	Severe hyperinflation and removal of fixed dates for first-time adopters. This amendment will not affect the Group's results.	Annual periods commencing on or after 1 July 2011
IFRS 7 (AC 144) amendment	Disclosures – Transfers of financial assets. The impact of this amendment on the Group's results cannot be determined at this stage.	Annual periods commencing on or after 1 July 2011
IFRS 9 (2009) (AC 146)	Financial instruments. The impact of this amendment on the Group's results cannot be determined at this stage.	Annual periods commencing on or after 1 January 2013
IFRS 9 (2010) (AC 146A)	Financial instruments. The impact of this amendment on the Group's results cannot be determined at this stage.	Annual periods commencing on or after 1 January 2013
IFRIC 14 (AC 447) amendment	Prepayments of a minimum funding requirement. The impact of this amendment on the Group's results cannot be determined at this stage.	Annual periods commencing on or after 1 January 2012
IAS 12 (AC102) amendment	Deferred tax: Recovery of underlying assets. The amendment is not expected to affect the Group's results.	Annual periods commencing on or after 1 January 2012

The Accounting Practices Board and the Financial Reporting Standards Council has announced that South African Statements of Generally Accepted Accounting Practice (SA GAAP) will be withdrawn and cease to apply in respect of financial years commencing on or after 1 December 2012. The CSIR will therefore adopt a new reporting framework, either International Financial Reporting Standards (IFRS) or Generally Recognised Accounting Practice (GRAP) for the financial year ending 31 March 2013.

	GROUP				CSIR			
	2012 R'000	**%**	2011 R'000	%	**2012 R'000**	**%**	2011 R'000	%
2 REVENUE								
Parliamentary Grant	**556 837**	**30**	535 357	31	**556 837**	**30**	535 357	31
Parliamentary Grant received	**549 111**	**30**	550 305	32	**549 111**	**30**	550 305	32
Less:								
Grant received for projects started before year-end but not completed	**(49 639)**	**(3)**	(57 365)	(3)	**(49 639)**	**(3)**	(57 365)	(3)
Add:								
Grant received in prior year for projects completed in this year	**57 365**	**3**	42 417	2	**57 365**	**3**	42 417	2
Contract R&D income	**1 270 045**	**70**	1 187 201	69	**1 273 400**	**70**	1 175 094	69
Local Private sector	**177 835**	**10**	185 781	11	**181 190**	**10**	193 362	11
Local Public sector	**952 909**	**52**	820 705	48	**952 909**	**52**	820 705	49
International sector (including Africa)	**139 301**	**8**	180 715	10	**139 301**	**8**	161 027	9
Royalties	**10 244**	**–**	8 616	–	**10 244**	**–**	8 616	–
	1 837 126	**100**	1 731 174	100	**1 840 481**	**100**	1 719 067	100

Contract R&D income is disclosed after taking into account the effect of the time value of money (the value of discounting) in terms of SAICA's Circular 9 of 2006: Transactions giving rise to adjustments to revenue/purchases. The value is R8,329 million (2011: R7,969 million) and is included in finance income (note 4).

Included in public sector contract R&D income is R55,45 million (2011: R64,97 million) ring-fenced allocation from the Department of Science and Technology for specific initiatives managed through memorandums of agreement.

Included in contract R&D income is rental income amounting to R27,99 million (2011: R24,45 million).

Estimates on Parliamentary Grant recognition are based on cost to completion, budgets and percentage of completion.

Notes to the Annual Financial Statements

for the year ended 31 March 2012

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

3 PROFIT BEFORE INCOME TAX

Profit before income tax is arrived at after taking the following items into account:

Audit fees	**4 744**	3 501	**4 669**	3 423
Fees for services	**6 214**	4 829	**5 991**	4 530
Patent costs	**5 616**	4 611	**5 393**	4 312
Legal costs	**598**	218	**598**	218
Operating leases	**11 371**	16 036	**11 340**	14 988
Buildings	**6 245**	8 839	**6 214**	7 791
Equipment	**3 795**	4 357	**3 795**	4 357
Vehicles	**1 331**	2 840	**1 331**	2 840
Net realised foreign exchange gain	**(13 644)**	(5 060)	**(13 644)**	(5 194)
Net unrealised foreign exchange (gain)/loss	**(4 112)**	1 619	**(4 112)**	1 676
Board members' and executive management's emoluments (note 19)	**15 549**	19 513	**14 954**	17 525
(Reversals of impairments)/impairments	**(3 702)**	187	**(3 180)**	(813)
(Reversal of impairment)/impairment on subsidiaries, joint ventures and associates	**(1 089)**	187	**(147)**	18
Reversal of impairment on trade receivables	**(3 033)**	(831)	**(3 033)**	(831)
Impairment on intangible assets	**420**	831	**–**	–
Provision for warranty	**–**	(53)	**–**	–
Bad debt written off	**1 154**	544	**1 154**	544
Write-down of inventory to net realisable value	**–**	230	**–**	230
(Profit)/loss on disposal and write-off of property, plant and equipment	**(307)**	5 506	**(307)**	5 499
Transfer of building to the Department of Public Works	**(21 929)**	–	**(21 929)**	–
Loss on disposal of interests in subsidiaries, joint ventures and associates	**4 727**	–	**5 185**	–
Lost and/or stolen equipment and vehicles*	**308**	800	**308**	800
Losses incurred	**308**	2 419	**308**	2 419
Losses recovered	**–**	(1 619)	**–**	(1 619)

* These are losses incurred in the normal course of the CSIR's business and are covered by the CSIR's insurance policy. The net losses incurred on these are included in the (profit)/loss on disposal and write-off of property, plant and equipment amounts.

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

4 FINANCE INCOME/EXPENSE

Finance income	**44 028**	58 861	**42 792**	57 243
Interest on bank balances and investments	**35 699**	50 892	**34 463**	49 274
Adjustment on initial recognition of contract R&D income*	**8 329**	7 969	**8 329**	7 969
Finance expense	**(4 419)**	(4 063)	**(4 419)**	(4 063)
Fair value adjustment on trade and other receivables	**–**	1	**–**	1
Adjustment on initial recognition of operating expenses*	**(4 419)**	(4 064)	**(4 419)**	(4 064)
	39 609	54 798	**38 373**	53 180

* These adjustments are due to the effect of the time value of money (the value of discounting) in terms of SAICA's Circular 9 of 2006: Transactions giving rise to adjustments to revenue/purchases.

	GROUP	
	2012	2011
	R'000	R'000

5 INCOME TAX EXPENSE

The CSIR is exempt from South African income tax in terms of section 10 (1) (t) (i) of the Income Tax Act, Act No 58 of 1962.

South African normal taxation due by subsidiaries	**–**	60
Current taxation	**–**	202
Deferred taxation – temporary differences	**–**	(142)
	–	60
South African normal rate of taxation	**28%**	28%
Profit attributable to tax-exempt entities	**(29%)**	(29%)
Assessed loss (refer note 13)	**1%**	1%
Current and deferred taxation – effective rate	**0%**	0%

Notes to the Annual Financial Statements

for the year ended 31 March 2012

6 PROPERTY, PLANT AND EQUIPMENT

	2012			2011		
	Cost R'000	**Accumulated depreciation** R'000	**Carrying value** R'000	Cost R'000	Accumulated depreciation R'000	Carrying value R'000
Group						
Land	**4 821**	**–**	**4 821**	5 549	–	5 549
Buildings	**333 053**	**67 857**	**265 196**	277 842	70 850	206 992
Equipment	**542 618**	**386 352**	**156 266**	630 098	453 314	176 784
Vehicles	**7 176**	**4 499**	**2 677**	7 426	4 271	3 155
	887 668	**458 708**	**428 960**	920 915	528 435	392 480
CSIR						
Land	**4 821**	**–**	**4 821**	5 549	–	5 549
Buildings	**333 053**	**67 857**	**265 196**	277 842	70 850	206 992
Equipment	**542 548**	**386 318**	**156 230**	627 767	451 358	176 409
Vehicles	**7 176**	**4 499**	**2 677**	7 426	4 271	3 155
	887 598	**458 674**	**428 924**	918 584	526 479	392 105

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 2010	5 549	172 202	169 380	3 072	**350 203**
Additions	–	40 138	49 773	539	**90 450**
Disposals and write-offs	–	(5 146)	(982)	(32)	**(6 160)**
Depreciation	–	(202)	(41 386)	(424)	**(42 012)**
Exchange differences on translation of foreign operations	–	–	(1)	–	**(1)**
Carrying value 31 March 2011	5 549	206 992	176 784	3 155	**392 480**
Additions	–	61 832	38 749	103	**100 684**
Disposals and write-offs	(728)	(2 047)	(1 262)	–	**(4 037)**
Transfer of the Satellite Application Centre (SAC)	–	(1 379)	(16 472)	(114)	**(17 965)**
Depreciation	–	(202)	(41 162)	(467)	**(41 831)**
Loss of control	–	–	(371)	–	**(371)**
Carrying value 31 March 2012	**4 821**	**265 196**	**156 266**	**2 677**	**428 960**
CSIR					
Carrying value 31 March 2010	5 549	172 202	168 360	3 072	**349 183**
Additions	–	40 138	49 634	539	**90 311**
Disposals and write-offs	–	(5 146)	(718)	(32)	**(5 896)**
Depreciation	–	(202)	(40 867)	(424)	**(41 493)**
Carrying value 31 March 2011	5 549	206 992	176 409	3 155	**392 105**
Additions	–	61 832	38 710	103	**100 645**
Disposals and write-offs	(728)	(2 047)	(1 262)	–	**(4 037)**
Transfer of the Satellite Application Centre (SAC)	–	(1 379)	(16 472)	(114)	**(17 965)**
Depreciation	–	(202)	(41 155)	(467)	**(41 824)**
Carrying value 31 March 2012	**4 821**	**265 196**	**156 230**	**2 677**	**428 924**

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 resulted in a R1,2 million (2011: R1,6 million) decrease in the depreciation amount for the current financial year.

Included above are assets with a cost of R228,4 million (2011: R306,1 million) that are fully depreciated as the remaining useful life is incidental.

During the current financial year, assets to the value of R83,6 million (2011: R28,5 million) were purchased with Government Grant funds. At year-end the cumulative value of assets purchased with Government Grant funds and shown at a nil cost is R320,3 million (2011: R244,2 million).

6.1 Non-current asset held for sale

A building with a cost of R94,89 million was transferred to the Department of Public Works in the 2011/12 financial year. The proceeds on sale of the building was received in a prior financial year and was disclosed as an advance received. Refer to note 14.

7 INTANGIBLE ASSETS

	2012			2011		
	Cost	**Accumulated amortisation & impairment**	**Carrying value**	Cost	Accumulated amortisation & impairment	Carrying value
	R'000	**R'000**	**R'000**	R'000	R'000	R'000
Group						
Investments in technology	**10 468**	**10 468**	**–**	10 555	10 537	18

	GROUP
	R'000
Carrying value 31 March 2010	46
Additions	858
Impairment*	(831)
Amortisation	(55)
Carrying value 31 March 2011	18
Additions	448
Loss of control	(18)
Impairment*	(420)
Amortisation	(28)
Carrying value 31 March 2012	**–**

* There are no guarantees of future cash flows and therefore the intangible assets have been impaired.

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

8 INTEREST IN JOINT VENTURES AND ASSOCIATES

Cost of investments less impairment losses	**1**	1	**1**	1
Loans to joint ventures and associates	**37 437**	33 937	**33 937**	33 937
Share of post-acquisition losses	**(19 249)**	(18 463)	**–**	–
Share of pre-acquisition gains	**151**	–	**–**	–
	18 340	15 475	**33 938**	33 938
Impairment of joint ventures and associates	**(12 968)**	(14 056)	**(32 637)**	(32 562)
	5 372	1 419	**1 301**	1 376

The loans to joint ventures and associates are interest free, unsecured and have no fixed terms of repayment.

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 2012 are as follows:

Name of joint venture/associate	Place of incorporation	Portion of ownership interest	Portion of voting power held	Principal activity	Carrying value		Financial year-end
					2012	**2011**	
					R'000	**R'000**	
Joint ventures							
Sera (Pty) Ltd	South Africa	50%	50%	Commercialisation and licensing of patents	**12 968**	14 056	31 March
Ellipsoid Technology (Pty) Ltd	South Africa	50%	50%	Development of encapsulation technology	**1 327**	1 419	31 March
Associates							
Uvirco Technologies (Pty) Ltd	South Africa	45%	45%	Manufacturing of high technology cameras	**4 045**	–	31 March
					18 340	15 475	

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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	
	2012 R'000	2011 R'000	**2012 R'000**	2011 R'000
Current assets	**27 489**	28 229	**8 667**	16
Non-current assets	**24 471**	22 593	**1 198**	–
Current liabilities	**44 958**	42 564	**5 453**	16
Non-current liabilities	**48 232**	48 232	**3 000**	–
Income	**1 597**	1 775	**16 629**	142
Expenses	**3 957**	3 752	**15 753**	142

9 INTEREST IN SUBSIDIARIES

	CSIR	
	2012 R'000	2011 R'000
Shares at cost less impairment losses	**4 650**	5 108
Indebtedness	**16 083**	21 088
– by subsidiaries	**32 500**	37 727
– impairment of loans	**(16 417)**	(16 639)
	20 733	26 196

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.

10 OTHER INVESTMENTS

	% held 2012	% held 2011	Number of shares held 2012	Number of shares held 2011	Class of shares	GROUP 2012 R'000	GROUP 2011 R'000	CSIR 2012 R'000	CSIR 2011 R'000
Unlisted shares						–	–	–	–
Breathetex (Pty) Ltd	–	–	12 000	12 000	Ordinary	–	11 025	–	11 025
	–	–	11 680	11 680	Preference				
Accumulated impairment losses						–	(11 025)	–	(11 025)
						–	–	–	–

Breathetex (Pty) Ltd was deregistered on 31 August 2011.

11 TRADE AND OTHER RECEIVABLES

	GROUP 2012 R'000	GROUP 2011 R'000	CSIR 2012 R'000	CSIR 2011 R'000
Trade receivables	**153 940**	92 752	**154 196**	99 089
Prepaid expenditure	**24 590**	24 157	**24 590**	24 156
Other receivables	**720**	1 600	**264**	386
	179 250	118 509	**179 050**	123 631

Trade receivables are shown net of impairment losses. Refer to note 22 for more detail on trade receivables.

12 INVENTORY AND CONTRACTS IN PROGRESS

	GROUP 2012 R'000	GROUP 2011 R'000	CSIR 2012 R'000	CSIR 2011 R'000
Contracts in progress less provision for losses	**66 680**	85 713	**66 680**	84 796
Raw materials and consumables	**821**	2 906	**821**	1 122
Work in progress	**–**	735	**–**	–
Finished goods	**–**	195	**–**	–
	67 501	89 549	**67 501**	85 918

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 R nil (2011: R230 154).

Notes to the Annual Financial Statements

for the year ended 31 March 2012

	GROUP	
	2012	2011
	R'000	R'000

13 DEFERRED TAX ASSET

Balance at the beginning of the year	**400**	258
Movement for the year:		
Accelerated capital allowances	**–**	32
Provisions	**–**	24
Income received in advance	**–**	86
Loss of control	**(400)**	–
	–	400

Two subsidiaries in the Group are in assessed loss positions and no deferred tax assets were raised for these assessed losses due to the uncertainty of the recoverability in future periods in respect of the carry forward of unused tax losses.

Opening balance	**6 144**	4 380
Amendment to 2009 assessment	**177**	–
Assessed tax loss generated for the year	**1 283**	1 764
Assessed tax loss carried forward	**7 604**	6 144

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

14 ADVANCES RECEIVED

Advances on contracts received from clients and stakeholders	**618 620**	628 626	**618 620**	628 626

Included in advances received is an amount of R nil (2011: R116,8 million excluding VAT) that relates to the transfer of a building to the Department of Public Works (refer note 6.1).

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

15 TRADE AND OTHER PAYABLES

Accounts payable and accruals	**298 124**	402 014	**297 444**	402 879
Salary-related accruals	**145 016**	124 528	**145 019**	124 003
	443 140	526 542	**442 463**	526 882

16 PROVISIONS

	2012		
	Opening balance	Loss of control	Closing balance
	R'000	R'000	R'000
GROUP			
Warranty provision	328	(328)	–
The warranty provision relates to goods sold under a 12 month warranty. The provision amount is determined based on a percentage of the replacement value of all sales made within the current financial year. This percentage is management's estimate of the likely returns of goods under warranty for repairs.			
	328	(328)	–

GROUP		CSIR	
2012	2011	**2012**	2011
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:	**2 501**	5 938	**2 442**	5 817
Land and buildings	**1 544**	4 311	**1 485**	4 190
Vehicles	**957**	1 627	**957**	1 627
Within two to five years:	**1 469**	2 442	**1 411**	2 442
Land and buildings	**58**	1 485	**–**	1 485
Vehicles	**1 411**	957	**1 411**	957

Agreements relating to operating lease payments for vehicles vary from 12 to 60 months and payments are fixed for the term of the agreements.

The CSIR leases buildings under operating leases. The lease periods vary from 24 to 60 months. Lease payments are increased with a fixed annual escalation percentage to reflect market rentals. None of the leases include contingent rentals.

Notes to the Annual Financial Statements

for the year ended 31 March 2012

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 R67,3 million (2011: R63,5 million) and employee contributions of R39,4 million (2011: R37,2 million) were expensed during the year.

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 and Sentinel (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 two employees (2011: two employees) who had formally converted their secondment to a CSIR appointment, employer contributions of R99 133 (2011: R92 222) and employee contributions of R54 771 (2011: R50 966) were expensed 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 one employee (2011: one employee) who is a member of the AIPF as at 31 March 2012. The fund is controlled by the state, which has assumed responsibility for the unfunded portions of these funds.

Employer contributions of R5 280 (2011: R9 847) and employee contributions of R3 300 (2011: R6 154) were expensed during the year.

18.4 Post-retirement medical benefits

The CSIR has a post-retirement medical benefit obligation to certain qualifying retired CSIR employees (pensioners) that joined the CSIR prior to 30 September 1996. An offer was made to qualifying pensioners in December 2005 to accept an annuity, payable from an independent source, equivalent to the value of their medical subsidy. The pensioners who accepted the offer are no longer entitled to a subsidy from the CSIR.

The accumulated benefit obligation and the annual cost of accrual of benefits are assessed by independent, qualified actuaries using the projected unit credit method. The estimated present value of the anticipated expenditure for the remaining 18 continuation members (2011: 24 continuation members) was recalculated by the actuaries as at 31 March 2012 and will be funded through cash and cash equivalents. These cash and cash equivalents have not been set aside specifically for this benefit.

	GROUP		CSIR	
	2012	2011	**2012**	2011
	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 statement of financial position arising from the CSIR's obligation in respect of post-retirement medical benefits is as follows:

Present value of obligations	**8 260**	10 142	**8 260**	10 142
Net liability on statement of financial position	**8 260**	10 142	**8 260**	10 142

Amounts recognised in the statement of comprehensive income in respect of the scheme are as follows:

Interest cost	**905**	860	**905**	860
Actuarial (gain)/loss recognised during the year	**(2 629)**	49	**(2 629)**	49
	(1 724)	909	**(1 724)**	909

Movement in the net liability recognised in the statement of financial position is as follows:

Net liability at the beginning of the year	**10 142**	9 875	**10 142**	9 875
Movement for the year	**(1 882)**	267	**(1 882)**	267
Net (income)/expense recognised in the statement of comprehensive income	**(1 724)**	909	**(1 724)**	909
Settlements	**(158)**	(642)	**(158)**	(642)
Net liability at the end of the year	**8 260**	10 142	**8 260**	10 142

Principal actuarial assumptions at the reporting date:

Discount rate at 31 March	**8.50%**	9.00%	**8.50%**	9.00%
Medical inflation costs	**4.30%**	4.80%	**4.30%**	4.80%

The above results are sensitive to changes in the assumed future rate of medical inflation.

The effect of a one-percent increase in the assumed future rate of medical inflation would have the following effects:

Effect on defined-benefit obligation	**591**	*755*	**591**	*755*

The effect of a one-percent decrease in the assumed future rate of medical inflation would have the following effects:

Effect on defined-benefit obligation	**(524)**	(664)	**(524)**	(664)

Historical information	**2012**	2011	2010	2009	2008
Present value of the defined-benefit obligation	**8 260**	10 142	9 875	8 862	8 595
Deficit in the plan	**8 260**	10 142	9 875	8 862	8 595

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19 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION

2012

	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	R'000
Board members and Executive Directors						
Dr SP Sibisi	CSIR	–	2 916	1 301	484	**4 701**
Non-executive Board members						
Mr G Badela (from January 2012)	CSIR	8	–	–	–	**8**
Mr N Behrens (until December 2011)	CSIR	41	–	–	–	**41**
Mr P Benadè	CSIR	94	–	–	–	**94**
Professor TE Cloete (from January 2012)	CSIR	8	–	–	–	**8**
Dr PH Goyns (from January 2012)	CSIR	–	–	–	–	**–**
Mr ADC Knott-Craig (until December 2011)	CSIR	55	–	–	–	**55**
Ms MSM Mabitje-Thompson (from January 2012)	CSIR	–	–	–	–	**–**
Professor TA Nyokong (from January 2012)	CSIR	8	–	–	–	**8**
Professor FW Petersen	CSIR	78	–	–	–	**78**
Mr M Sibanda	CSIR	91	–	–	–	**91**
Mr M Silinga (until December 2011)	CSIR	33	–	–	–	**33**
Ms KL Thoka (until December 2011)	CSIR	41	–	–	–	**41**
Ms BS Tshabalala (from January 2012)	CSIR	8	–	–	–	**8**
Professor MJ Wingfield	CSIR	50	–	–	–	**50**
Executive Management						
Dr RK Chikwamba (from March 2012)	CSIR	–	121	–	9	**130**
Dr T Dlamini (until December 2011)	CSIR	–	1 436	551	111	**2 098**
Dr JH Maree	CSIR	–	1 809	661	265	**2 735**
Mr CR Sturdy	CSIR	–	1 656	644	303	**2 603**
Mr RM Zondo	CSIR	–	1 564	451	157	**2 172**
Subsidiaries						
Non-executive Board member						
Mr M Sibanda (from November 2011)	Technifin (Pty) Ltd	9	–	–	–	**9**
Executive Management						
Mr JG Hattingh (from November 2011)	Technifin (Pty) Ltd	–	490	–	96	**586**
2012		**524**	**9 992**	**3 608**	**1 425**	**15 549**

19 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION (continued)

2011

	Entity	Fees for services as director	Managerial Services: Basic salary	Managerial Services: Bonuses and performance-related payments	Managerial Services: Retirement fund and medical aid contributions	Total
		R'000	R'000	R'000	R'000	R'000
Board members and Executive Directors						
Dr SP Sibisi	CSIR	–	2 720	1 678	452	4 850
Foreign subsidiaries						
Mr AA Davidson	Quotec Limited (UK)	–	917	–	16	933
Dr A Hickman	Quotec Limited (UK)	–	1 040	–	15	1 055
Remunerated in British pound						
Non-executive Board members						
Mr N Behrens	CSIR	47	–	–	–	47
Mr P Benadè (from September 2010)	CSIR	42	–	–	–	42
Professor DR Hall (until March 2011)	CSIR	16	–	–	–	16
Mr ADC Knott-Craig	CSIR	79	–	–	–	79
Professor FW Petersen	CSIR	64	–	–	–	64
Mr M Sibanda	CSIR	79	–	–	–	79
Mr M Silinga	CSIR	42	–	–	–	42
Ms KL Thoka	CSIR	47	–	–	–	47
Professor M Wingfield	CSIR	47	–	–	–	47
Executive Management						
Dr T Dlamini	CSIR	–	1 587	648	137	2 372
Dr JH Maree	CSIR	–	1 646	778	242	2 666
Ms K Njobe (until March 2011)	CSIR	–	1 621	662	200	2 483
Mr CR Sturdy	CSIR	–	1 555	716	264	2 535
Mr RM Zondo	CSIR	–	1 422	591	143	2 156
2011		**463**	**12 508**	**5 073**	**1 469**	**19 513**

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	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

20 CONTINGENT LIABILITIES AND FACILITIES

Facilities of subsidiaries guaranteed by the CSIR	**20 000**	20 000	**20 000**	20 000

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.

21 CAPITAL COMMITMENTS

Property, plant and equipment	**31 150**	9 337	**31 150**	9 337

This capital expenditure is to be financed from internal sources.

22 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 and Risk 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 and Risk 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 and Risk Committee.

22 FINANCIAL INSTRUMENTS (continued)

22.1 Market risk

Market risk is the risk that changes in market prices, such as foreign exchange rates and interest rates will affect the Group's income or the value of its holdings of financial instruments. The objective of market risk management is to manage and control market risk exposures within acceptable parameters, while optimising the return.

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 currency of the Group entities 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:

	31 MARCH 2012					
	Total R'000	**ZAR R'000**	**EURO R'000**	**USD R'000**	**GBP R'000**	**Other R'000**
Trade receivables	**153 940**	118 820	198	34 119	73	730
Bank accounts	**152 822**	51 884	8 513	91 068	679	678
Trade payables	**(443 140)**	(441 486)	(181)	(780)	(575)	(118)
Gross statement of financial position exposure	**(136 378)**	(270 782)	8 530	124 407	177	1 290
Forward exchange contracts	**–**	–	–	–	–	–
Net exposure	**(136 378)**	**(270 782)**	**8 530**	**124 407**	**177**	**1 290**

	31 MARCH 2011					
	Total R'000	ZAR R'000	EURO R'000	USD R'000	GBP R'000	Other R'000
Trade receivables	92 752	77 860	2 950	10 491	1 088	363
Bank accounts	179 663	92 143	17 336	68 378	1 745	61
Trade payables	(526 542)	(518 275)	(2 349)	(4 903)	(996)	(19)
Gross statement of financial position exposure	(254 127)	(348 272)	17 937	73 966	1 837	405
Forward exchange contracts	(1 109)	–	–	–	–	(1 109)
Net exposure	(255 236)	(348 272)	17 937	73 966	1 837	(704)

	GROUP	
	2012	2011

22 FINANCIAL INSTRUMENTS (continued)

22.1 Market risk (continued)

Foreign currency risk (continued)

The following significant exchange rates applied during the year:

Average rate of forward exchange contracts	**R**	R
CHF	**–**	7.4239
Year-end spot rate		
Euro	**10.2515**	9.6418
USD	**7.6855**	6.8387
GBP	**12.2879**	10.9642
Average rate used for translating foreign operations		
GBP	**–**	11.1824

Sensitivity analysis

A 10% strengthening of the rand against the following currencies at 31 March would have 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 2011.

	R'000	R'000
Euro	**(853)**	(1 794)
USD	**(12 441)**	(7 397)
GBP	**(18)**	(184)
Other	**(129)**	70

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 as follows:

Fixed rate instruments: Carrying amount

	R'000	R'000
Financial assets: Fixed deposits	**452 633**	567 795

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 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.

	GROUP	
	2012	2011
	R'000	R'000

22 FINANCIAL INSTRUMENTS (continued)

22.1 Market risk (continued)

Interest rate risk (continued)

Variable rate instruments: Carrying amount

Financial assets: Call deposits	**363 000**	261 289
Financial assets: Bank balances	**152 822**	179 663
	515 822	440 952

Sensitivity analysis

An increase of 100 basis points in interest rates at the reporting date would have increased equity and profit and loss by the amounts shown below. This analysis assumes that all other variables, in particular foreign currency rates, remain constant. The analysis is performed on the same basis for 2011.

Variable rate instruments	**5 158**	4 410

A decrease of 100 basis points would have had the equal but opposite effect to the amounts shown above.

22.2 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 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 20 for details on bank guarantees issued with respect to facilities.

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22 FINANCIAL INSTRUMENTS (continued)

22.2 Credit risk (continued)

	GROUP	
	2012	2011
	R'000	R'000
Exposure to credit risk		
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:		
– *Current fixed deposits*	**452 633**	567 795
Other cash and cash equivalents:		
– *Call deposits*	**363 000**	261 289
– *Bank balances*	**152 822**	179 663
– *Cash on hand and cash deposits*	**640**	656
Loans and receivables:		
– *Trade and other receivables*	**179 250**	118 509
– *Contracts in progress less provision for losses*	**66 680**	85 713
	1 215 025	1 213 625
The maximum exposure to credit risk for trade receivables at the reporting date by type of customer was:		
Local public	**81 937**	76 253
Local private	**35 989**	727
International	**36 014**	15 772
	153 940	92 752

The Group's most significant customers are government institutions.

22 FINANCIAL INSTRUMENTS (continued)

22.2 Credit risk (continued)

Exposure to credit risk (continued)

	GROUP			
	2012		2011	
	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	**105 394**	**138**	54 021	387
Past due 0 – 30 days	**25 942**	**172**	19 748	342
Past due 31 – 120 days	**11 720**	**1 085**	18 965	807
Past due more than 120 days	**18 118**	**5 839**	10 285	8 731
	161 174	**7 234**	103 019	10 267

The movement in the allowance for impairment in respect of trade receivables during the year was as follows:

	GROUP	
	2012 R'000	2011 R'000
Balance at 1 April	**10 267**	11 098
Impairment loss reversed	**(3 033)**	(831)
Balance at 31 March	**7 234**	10 267

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 R6,3 million (2011: R7,6 million), utilisation of R1,4 million (2011: R2,6million) and new impairment allowances of R4,7 million (2011: R9,4 million).

22.3 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 R500 000 (2011: R500 000) available.

22 FINANCIAL INSTRUMENTS (continued)

22.3 Liquidity risk (continued)

The following are the contractual maturities of financial liabilities, including interest payments and excluding the impact of netting agreements for the Group:

	GROUP					
	2012			2011		
	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	(443 140)	(443 140)	–	(526 542)	(526 542)	–
Derivative financial liabilities						
Forward exchange contracts	–	–	–	(28)	(1 136)	–
	(443 140)	(443 140)	–	(526 570)	(527 678)	–

Rate of forward exchange contracts:

	GROUP	
	2012	2011
	R	R
CHF	–	7.6104

22.4 Fair values

At 31 March 2012 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.

22.5 Fair value hierarchy

The table below analyses financial instruments carried at fair value, by valuation method. The different levels have been defined as follows:

Level 1: quoted prices (unadjusted) in active markets for identical assets or liabilities
Level 2: inputs other than quoted prices included within Level 1 that are observable for the asset or liability, either directly (as prices) or indirectly (derived from prices)
Level 3: inputs for the asset or liability that are not based on observable market data (unobservable inputs).

22 FINANCIAL INSTRUMENTS (continued)

22.5 Fair value hierarchy (continued)

	Level 1	Level 2	Level 3	Total
31 March 2012				
Forward exchange contracts	–	–	–	–
31 March 2011				
Forward exchange contracts	–	(28)	–	(28)

23 RECONCILIATION OF OPERATING PROFIT TO CASH GENERATED FROM OPERATING ACTIVITIES

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000
Operating profit for the year before taxation	**65 584**	33 955	**68 998**	35 511
Adjusted for:				
Loss on disposal of interest in subsidiaries, joint ventures and associates	**4 727**	–	**5 185**	–
Depreciation and amortisation	**41 859**	42 067	**41 824**	41 493
Net unrealised foreign exchange (gain)/loss	**(4 112)**	1 619	**(4 112)**	1 676
Net finance income	**(39 609)**	(54 798)	**(38 373)**	(53 180)
Post-retirement medical benefits	**(1 724)**	909	**(1 724)**	909
Straight-lining adjustment of operating leases	**(307)**	(148)	**(307)**	(148)
Leave accrual and warranty provision	**8 638**	3 912	**8 638**	3 939
(Reversals of impairments)/impairments	**(3 702)**	187	**(3 180)**	(813)
(Profit)/loss on disposal and write-off of property, plant and equipment	**(22 236)**	5 506	**(22 236)**	5 499
Share of loss/(profit) of joint ventures and associates	**786**	(119)	**–**	–
Bad debt written off	**1 154**	544	**1 154**	544
Write-down of inventory to net realisable value	**–**	230	**–**	230
Operating profit before changes in working capital	**51 058**	33 864	**55 867**	35 660
(Increase)/decrease in trade and other receivables	**(57 256)**	10 020	**(54 321)**	6 247
Decrease/(increase) in inventory and contracts in progress	**18 933**	(9 427)	**18 933**	(7 900)
Increase in advances received	**111 744**	134 683	**111 744**	134 683
(Decrease)/increase in trade and other payables and provisions	**(89 015)**	77 501	**(93 276)**	77 302
Net working capital changes	**(15 594)**	212 777	**(16 920)**	210 332
Cash generated from operating activities	**35 464**	246 641	**38 947**	245 992

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for the year ended 31 March 2012

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000
24 CASH AND CASH EQUIVALENTS				
Fixed deposits	**452 633**	567 795	**436 000**	543 000
Call deposits	**363 000**	261 289	**361 000**	255 000
Bank balances	**152 822**	179 663	**151 721**	177 107
Cash on hand and cash deposits	**640**	656	**639**	648
	969 095	1 009 403	**949 360**	975 755

25 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 and provincial sphere of government. Amounts due from/(to) these entities are subject to the same terms and conditions as normal trade receivables and trade payables. For detail on individually significant transactions refer to notes 2, 3, 6.1, 14 and 26.

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	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

25 RELATED PARTY TRANSACTIONS (continued)

25.1 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	**24**	10	**24**	10
Services received	**1**	93	**1**	93
Amount due to	**–**	(2)	**–**	(2)
Major public entities				
Services rendered	**285 293**	233 232	**285 293**	233 232
Services received	**19 038**	25 570	**19 038**	25 570
Amount due from	**23 238**	10 112	**23 238**	10 112
National public entities				
Services rendered	**71 796**	70 720	**71 796**	70 720
Services received	**5 074**	8 334	**5 074**	8 334
Amount due from	**28 433**	15 268	**28 433**	15 268
National government business enterprises				
Services rendered	**4 465**	2 722	**4 465**	2 722
Services received	**689**	4 789	**689**	4 789
Amount due from	**859**	805	**859**	805
Provincial public entities				
Services rendered	**834**	377	**834**	377
Amount due from	**381**	–	**381**	–
Provincial government business enterprises				
Services rendered	**4 269**	3 278	**4 269**	3 278
Services received	**–**	175	**–**	175
Amount due from	**783**	421	**783**	421

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for the year ended 31 March 2012

	GROUP		CSIR	
	2012	2011	**2012**	2011
	R'000	R'000	**R'000**	R'000

25 RELATED PARTY TRANSACTIONS (continued)

25.1 Transactions with related parties (continued)

Government departments				
Services rendered	**1 084 391**	968 636	**1 084 391**	968 636
Services received	**6 724**	43 251	**6 724**	43 251
Amount due from	**21 170**	42 622	**21 170**	42 622
Subsidiaries				
Services rendered			**3 592**	9 580
Services received			**77**	4 703
Amount due from			**202**	4 017
Associates				
Services rendered	**2 555**	280	**2 555**	280
Services received	**84**	–	**84**	–
Amount due from	**1 418**	–	**1 418**	–

25.2 Transactions with key management

Total remuneration of key management is included in employees' remuneration (refer to note 19 for Executive Management's remuneration).

26 SATELLITE APPLICATION CENTRE (SAC)

In terms of the South African National Space Agency Act, Act No 36 of 2008, the South African National Space Agency (SANSA) was established as a separate public entity, the Executive Authority of which is the Minister of Science and Technology.

Pursuant to the said Act, all rights, obligations, assets and liabilities acquired or incurred by the Satellite Applications Centre (SAC) were, by agreement, transferred to SANSA as from 1 April 2011 and similarly all employees of the former SAC were transferred to SANSA. This transfer was accounted for as a common control transaction with the Department of Science and Technology being the ultimate holding entity and therefore the assets and liabilities were transferred at their carrying values. In the prior financial year this transfer was disclosed as a subsequent event.

Assets and liabilities attributable to SAC are as follows:

	2012 R'000
ASSETS	
Non-current assets	17 965
Property, plant and equipment	17 965
Current assets	20 344
Trade and other receivables	4 036
Inventory and contracts in progress	192
Bank balances and cash on hand	16 116
TOTAL ASSETS	38 309
EQUITY AND LIABILITIES	
Reserves	25 693
Retained earnings	25 693
Current liabilities	12 616
Advances received	4 930
Trade and other payables	7 686
TOTAL EQUITY AND LIABILITIES	38 309
The net assets of SAC on transfer were as follows:	
Net asset value transferred	25 693
Net cash outflow arising on transfer of SAC	
Bank balance and cash disposed	(11 945)

27 DISPOSAL OF INTERESTS IN SUBSIDIARIES AND ASSOCIATES

27.1 Quotec Limited

The Group held 100% of the issued share capital in Quotec Limited. The shares held were sold effective 1 April 2011.

The net assets of Quotec Limited on 1 April 2011 were as follows:

	2012 R'000
Net asset value disposed	4 543
Loss on disposal	(4 543)
Total consideration	–
Net cash outflow arising on disposal of interest in subsidiary	
Bank balance and cash disposed	(4 213)

27 DISPOSAL OF INTERESTS IN SUBSIDIARIES AND ASSOCIATES (continued)

27.2 Uvirco Technologies (Pty) Ltd

The Group held 100% of the issued share capital in Uvirco Technologies (Pty) Ltd. On 1 April 2011 Uvirco Technologies (Pty) Ltd issued additional shares. This resulted in the Group's interest reducing to 45%.

55% of the net assets of Uvirco Technologies (Pty) Ltd on 1 April 2011 were as follows:

	2012 R'000
Net asset value disposed	184
Loss on disposal	(184)
Total consideration	–
Net cash outflow arising on disposal of interest in subsidiary	
Bank balance and cash disposed	(2 966)

27.3 Eyeborn (Pty) Ltd

The Group held 26% of the issued share capital in Eyeborn (Pty) Ltd. The shares held were sold effective 1 November 2011. The investment in Eyeborn (Pty) Ltd was fully impaired in the Group financial statements. No profit or loss was realised on disposal of these shares.

Addendum A: Interest in subsidiaries

31 March 2012

Consolidated subsidiaries	Country of incorporation	Interests of the CSIR					
		Issued capital	Effective holding		Financial year-end	Shares at cost less accumulated impairment losses	
			2012	2011		2012	2011
		R'000	%	%		R'000	R'000
Direct investments							
Technology Finance Corporation (Pty) Ltd (Technifin)	South Africa	**5 200**	**100**	100	31 March	**4 650**	4 650
Technovent (Pty) Ltd	South Africa	**5 000**	**100**	100	31 March	**–**	–
Quotec Limited	United Kingdom	**20**	**–**	100	31 March	**–**	458
						4 650	5 108
Indirect investments							
Included in Technovent (Pty) Ltd carrying value:							
Uvirco Technologies (Pty) Ltd*	South Africa	–	**45**	100	31 March	**–**	–

* Issued capital R400 and shares at cost R180

The Group has interests in three dormant companies. Details of these interests are available at the CSIR's registered office.

Addendum A: Interest in subsidiaries

31 March 2012

Interests of the CSIR						
Net indebtedness less accumulated impairment losses to subsidiaries		by subsidiaries		Net investment		General nature of business
2012 R'000	2011 R'000	**2012 R'000**	2011 R'000	**2012 R'000**	2011 R'000	
–	–	**12 000**	12 000	**16 650**	16 650	The acquisition and transfer of technology to industry by licensing new inventions, providing finance to develop technology and venture capital for the exploitation thereof.
–	–	**4 083**	4 361	**4 083**	4 361	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.
–	–	–	4 727	–	5 185	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.
–	–	**16 083**	21 088	**20 733**	26 196	
						The company manufacturesand distributes high technology cameras for use in detecting faults on overhead electricity distribution lines.

Abbreviations

ACCESS	the Applied Centre for Climate and Earth Systems Science
AISI	Aerospace Industry Support Initiative
ANDI	African Network for Drugs and diagnostics Innovation
ARTIST	Adaptive Real-time Internet Streaming Technology
B-BBEE	Broad-Based Black Economic Empowerment
CAIR	Centre for Artificial Intelligence Research
CEO	Chief Executive Officer
CHPC	Centre for High Performance Computing
CORDEX	Coordinated Regional Downscaling Experiment
CSAG	Climate Systems Analysis Group
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of Southern Africa
DIFR	Disabling injury frequency rate
DIRISA	Data Intensive Research Infrastructure of South Africa
DoH	Department of Health
DST	Department of Science and Technology
ECD	Enterprise Creation for Development
GAW	Global Atmospheric Watch
HCD	Human Capital Development
HEI	Higher Education Institution
HiMA	High-modulus asphalt
HMD	Helmet-mounted Display
HR	Human Resources
ICT	Information and Communications Technology
IP	Intellectual Property
IPAP	Industrial Policy Action Plan
IPCC	Intergovernmental Panel on Climate Change
IPMD	Integrated Planning and Development Modelling
iPSC	Induced Pluripotent Stem Cell
KPI	Key Performance Indicator
KRA	Key results area
MDR	Multidrug-resistant
MoA	Memorandum of agreement
MoU	Memorandum of understanding
NCPC-SA	National Cleaner Production Centre of South Africa
NFTN	National Foundry Technology Network
NRF	National Research Foundation
NSI	National System of Innovation
OEM	Original Equipment Manufacturer
PAA	Public Audit Act
PFMA	Public Finance Management Act
PG	Parliamentary Grant
RAP	Research Advisory Panel
RIA	Research Impact Area
R&D	Research and Development
SAAF	South African Air Force
SABITA	Southern African Bitumen Association
SALT	South African Large Telescope
SANDF	South African National Defence Force
SANReN	South African National Research Network
SANS	South African National Standard
SAWS	South African Weather Service
SET	Science, engineering and technology
SETI	Science, Engineering and Technology Institute
SEWES	Sensors and Electronic Warfare Engagement Simulation
SKA	Square Kilometre Array
SITA	State Information Technology Agency
SOE	State-Owned Enterprise
SRP	Strategic Research Panel
TAP	Technology Assistance Programme
TB	Tuberculosis
the dti	Department of Trade and Industry
THRIP	The Human Resources for Industry Programme
TiCoC	Titanium Centre of Competence
UAS	Unmanned Aerial Systems
UAV	Unmanned Aerial Vehicle
UIRI	Uganda Industrial Research Institute
UKZN	University of KwaZulu-Natal
UNICEF	United Nations Children's Fund

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