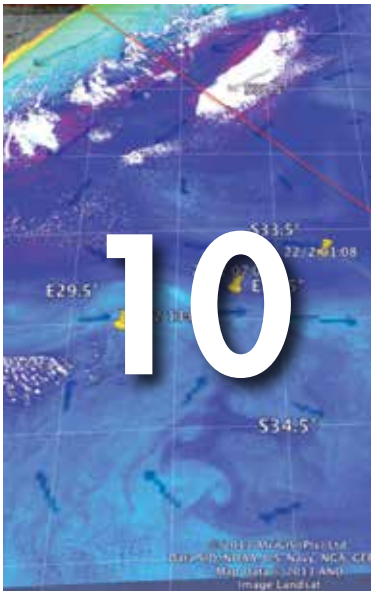
Our future through

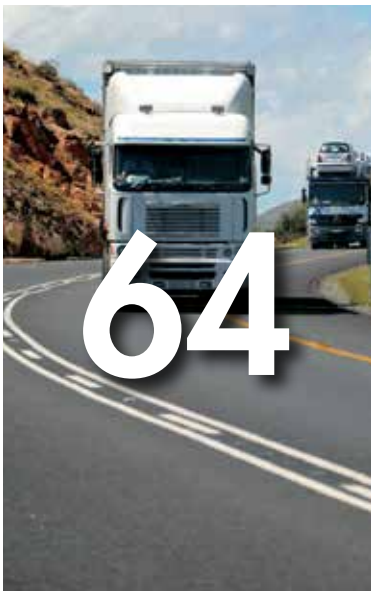
SCIENCE

2013/14 ANNUAL REPORT

CSIR

our future through science





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 Executive Authority is the Minister of the Department of Science and Technology.

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REPUBLIC OF SOUTH AFRICA

CSIR
our future through science

Foreword

By the Minister of Science and Technology

The CSIR, a multidisciplinary science and technology research council, meets the very highest scientific standards and harnesses science and technology in the service of national development. It is part of a concerted national effort to direct our scientific resources towards the aim of providing a better life for all our people.

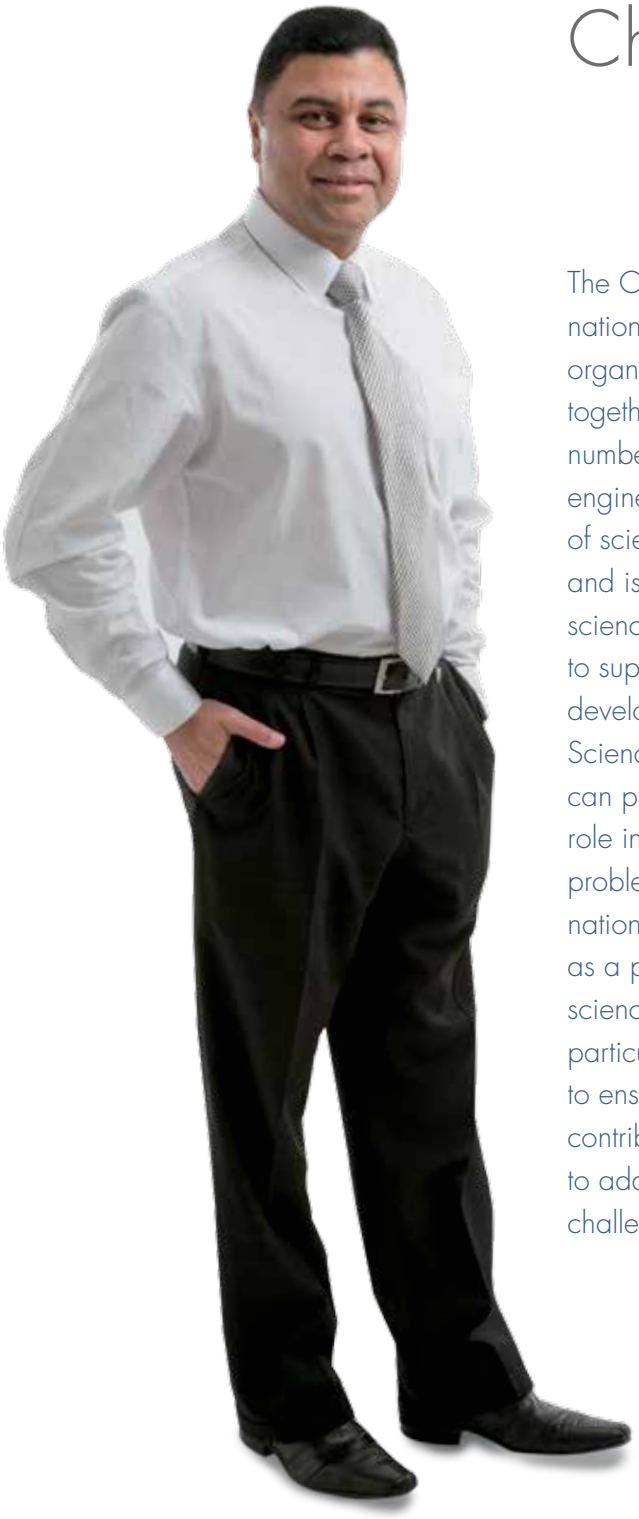
In the vision statement of the National Development Plan (NDP) that describes what South Africa will be like in 2030, we find the following sentence: "We are fascinated by scientific invention and its use in the enhancement of our lives." If this vision is to become a reality, institutions like the CSIR will not only have to ensure that technological innovation delivers real benefits that improve the lives of South Africans, but will also have to ensure the linkages between our investment in science and its effects on our society are clearly communicated.

The NDP lists some 87 actions that will be required to transform our country. Some of these actions require explicit policy interventions, while others are focused on the implementation of particular projects or systems. It is clear that scientific and technological innovation will not be a panacea to our developmental problems – not all of these actions are amenable to, or require, scientific input. However, science and technology will play a special and irreplaceable role in a wide range of areas – in the development of the industries and services that will provide the meaningful employment we so desperately need; and in identifying where our service delivery systems are failing and where innovation can provide the 'step change' that will deliver increased value and free up valuable resources to tackle other problems. The value of the CSIR, and the reason that the people of South Africa have invested so much of their resources into creating and sustaining this organisation, is that we now have the ability to identify and solve these critical problems in a focused and directed manner.

This annual report contains numerous examples of how these fundamental problems are being addressed by the CSIR and its scientific partners. These examples range from the long-term work that will guide our responses to the threats posed by our changing climate to the immediate task of building, maintaining and improving our transport infrastructure; from the laboratory desk where our future economy is being nurtured by scientists working on the fundamental properties of lasers and genes, to immediate development prospects that lie untapped in our waste dumps; and from direct interventions that will save the lives of newborn babies to programmes that reduce the burden on our energy system by using electricity more efficiently.

I congratulate the CSIR on yet another excellent performance during the 2013/14 financial year and urge it to redouble its efforts to assist in the transformation of our society. The CSIR's track record of scientific and administrative excellence must now be even more actively translated into actions that address our national priorities of reducing inequality, poverty and unemployment.

MRS NALEDI PANDOR



Chairman's overview

The CSIR is a unique national asset, an organisation that brings together a substantial number of scientists and engineers across a range of scientific disciplines and is committed to using science and technology to support South Africa's developmental goals. Science and technology can play a critical role in resolving the problems facing our nation, and the CSIR, as a publicly-funded science council, has a particular responsibility to ensure that its work contributes meaningfully to addressing those challenges.

Looking back at the 2013/14 financial year, the CSIR has once again received an unqualified audit and delivered excellent results with respect to financial performance, governance, human resources and scientific outputs. There are, however, a number of issues that we will continue to work on in the years ahead; issues that centre on our ability to demonstrate the value of the substantial investment that has been made in this organisation by the South African people, our ability to both deliver impact and to communicate the value of that impact to all of our stakeholders. In addressing these issues, we plan to:

- Maintain the highest scientific standards – it is only by doing good research that we will deliver sustainable solutions to our country's problems. During the past year CSIR staff have continued to produce excellent work by publishing their results in leading journals; by producing path-breaking results in areas as diverse as genetics, materials science, ecology and lasers; and being recognised by their international peers as leading experts in their fields. We need to identify and strengthen the systems that have produced these achievements.

- Sharpen our focus on resolving the challenges identified in the National Development Plan (NDP). This report contains many examples of how the CSIR, in collaboration with our partners in the National System of Innovation (NSI), is currently addressing those challenges – examples include the use of technology in the delivery of health; the maintenance and development of our transport infrastructure; the incubation of new industries; and the protection of our natural resources. We also require more structured organisation-wide engagement with the NDP, to ensure that we are able to prioritise our interventions and that those interventions form part of a co-ordinated NSI response.
- Improve our ability to measure and communicate the impact of our work, particularly the national priorities of reducing unemployment, poverty and inequality. A critical first step in moving research and development (R&D) spending from the current level of 0.76% of gross domestic product (GDP) to the national target of 1.5% of GDP is demonstrating the value that the country receives from the current expenditure. In response to this need the CSIR has renewed its integrated marketing and communication strategy – together with the implementation of our impact assessment framework. This will contribute to a significant improvement in the visibility of the organisation and the valuable work that it performs.

It is important that we measure ourselves against international organisations that perform similar functions – this allows us to continue to set ambitious but achievable targets, as well as identify areas in which we need to improve. The CSIR commissioned an international consulting firm, Arthur D Little, to conduct such an international bench-marking exercise, and the results in the main affirm much of the good work already being done by the CSIR in areas such as building and transforming human capital, collaborating with higher education institutions and the generation of licensing and royalty revenue. There are, however, areas in which we need to improve, most notably, improving the qualifications of our science, engineering and technology base and the rate at which we publish. As part of this on-going process to sharpen the focus of our scientific programmes the Board will commission a thorough review of the CSIR's work in the biosciences environment in the coming year.

The Board will also continue to focus on the CSIR's intellectual property and commercialisation in order to optimise the benefits of our scientific and technological work, both for the organisation and the country in general. The Board is also aware of the need to assess and manage the risks faced by the organisation, and to this end will review and refine our enterprise risk management system.

The tenure of the current Board will come to an end in December 2014. Thank you to the Board members for their contribution during this period. We wish to also extend our gratitude to the Department of Science and Technology and its leadership team for their unwavering support and their commitment to ensuring that we deliver on our mandate.

Finally, we would like to thank the staff and executive management of the CSIR for their hard work. We wish them well as they continue to harness science and technology to improve the lives of all South Africans.

PROFESSOR FRANCIS PETERSEN

CEO's introduction

South Africa's development landscape underwent a significant change between 2010 and 2011 with the release of the National Planning Commission's *Diagnostic Overview* and the *National Development Plan: Vision 2030* respectively. We now had a reasonably clear and concise statement of the problems we faced as a nation and the potential solutions to these problems.

In setting out the waypoints that would have to be traversed on our way to realising our national development vision, the National Development Plan (NDP) provided a partial but significant answer to the question – "How do we judge the impact of our work?". In at least one respect we will be judged by the extent to which our scientific endeavours support the vision of the NDP. Therefore the question of how we allocate our resources will become ever-more critical, and the opportunity cost of each action must be carefully weighed – we can not take refuge behind the easy excuses of expediency or urgency. We must now attempt to judge ourselves as harshly as future generations will judge us; when the dimensions of our problems have been uncovered and the potential solutions have been identified – did we play the strategic role required by our mandate?

While the NDP has set out the broad parameters of the response required, our task, in collaboration with our partners in the National System of Innovation (NSI), is to identify the critical points at which science, engineering and technology interventions are required; those points at which research and innovation will remove an obstacle that would otherwise have impeded all further progress; those points at which scientific solutions will produce efficiencies that will free up valuable resources to address other problems; and finally those points

at which the very nature of the intervention contributes substantively to the national goal of transforming our society.

Our existing strategic initiatives, the Research Impact Areas and Flagship Programmes will be reviewed and, where necessary, refined to deliver an integrated response – both within the CSIR and from the perspective of the NSI – to our developmental needs.

All of these important decisions continue to take place within the context of delivering high-quality scientific research. As South Africa moves towards the goal of approximately doubling the proportion of gross domestic product spent on research and development (R&D), we have a particular responsibility to maintain the highest scientific standards. It is unlikely that the increased spending on R&D will deliver the results our country so dearly needs if we allow our standards to slip.

We have a solid base of directed high-impact research outputs from which to work – the examples contained in the project highlights section of this report illustrate the extent to which we already respond to national priorities. Consider, for example, the issue of our contribution to economic growth. We find that our work is contributing to improving the efficiency of our current economic processes (the work of the National Cleaner Production Centre of South Africa and the innovative use of lasers in welding processes); incubating and nurturing the industries and products that will provide the jobs of the future (the Titanium Centre of Competence, the Biomanufacturing Industry Development Programme and developing innovative methods of using bandwidth allocated to television to deliver internet access); and ensuring the existence of the environment in which future economic development will take place (by improving the efficiency of our road, rail and port infrastructure and by understanding the challenges we will face due to climate change and how to best mitigate these effects at the national, regional and international level).

Another example can be found in our contribution to the improved delivery of health care. CSIR researchers, in partnership with other national agencies, have now tested technologies that overcome the logistical challenges associated with obtaining blood-test results in remote areas; we have developed the technology for diagnosing potentially fatal restrictions to fetal growth; and we are assisting the Department of Health with overcoming some of the technical challenges in support of the National Health Insurance programme.

In pursuance of our mandate we will continue to build on the strategic partnerships we have put in place with key national and international institutions. These include government departments that are responsible for service delivery, state-owned enterprises such as Eskom and Transnet, development agencies such as the Development Bank of Southern Africa and the Industrial Development Corporation, and of course our partners in the NSI.

Of course all of these achievements would not be possible without the hard work and dedication of all CSIR staff members – their passion and commitment transform our mandate from a mere collection of words into something real and meaningful.

I would also like to thank the CSIR Board members for their hard work and guidance over the past three years, and my Executive team for the support and input they have provided. Finally, I would like to thank the Department of Science and Technology and its leadership for their ongoing support and critical engagement.

DR SIBUSISO SIBISI

Research, development and implementation

Project highlights

South Africa faces a myriad of challenges in its quest to stimulate and sustain economic growth; eliminate inequalities; broaden access to quality health care, infrastructure and knowledge-generating technologies; and to keep our people and natural resources safe.

Drawing on its multidisciplinary skills base, the CSIR aims to support the country's response to national priorities through research, development and implementation in the areas of health, industry, defence and security, the natural and built environments and energy. We also apply our capabilities beyond the South African border, supporting sustainable development in a number of African countries.

Research, development and implementation for the

Natural environment

South Africa is a resource-intensive economy facing the twin challenges of declining natural resources and deepening inequalities. These challenges can be addressed by managing and protecting our resources and using them to provide sustainable employment opportunities.

The CSIR is supporting sustainable development by contributing to international efforts to understand the nature of climate change, by mapping the threats to our water sources and by investigating the potential economic benefits that will flow from improved waste management policies.

< Dr Moses Cho, a remote sensing scientist at the CSIR, measures leaf area index, a key characteristic of forest productivity. Researchers study the state of vegetation in an area to identify stressed or endangered species and to measure the impact of human activity.

PROJECT HIGHLIGHTS

Natural environment

SOUTHERN OCEAN MEASUREMENTS TO UNDERSTAND CLIMATE CHANGE

Ocean robotics platforms are deployed from the research ship, SA Agulhas II, into the Southern Ocean to collect valuable data, used to understand and project climate change. Factors which influence the global carbon cycle in the Southern Ocean are measured, such as salinity, temperature, dissolved oxygen, light and chlorophyll levels.

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INVESTIGATING LAND-USE AFTER MINING

The CSIR, in partnership with Rio Tinto's Richards Bay Minerals, runs a post-mining, alternative land-use programme in KwaZulu-Natal, an initiative that contributes to the establishment of a green economy in South Africa.

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TOWARDS WASTE AS A RESOURCE

Global trade in waste plastic, an estimated 12 million tonnes, is valued at $5 billion per year, with about 70% of the global market destined for China. South Africa also exports some recovered plastic, however, 90% of the country's total waste ends up in landfills. A shift in thinking now explores the value of waste as secondary resource in ways that can benefit the South African economy.

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PROJECT HIGHLIGHTS

Natural environment

BETTER MANAGEMENT OF E-WASTE

Rapid technological advancement renders electronic equipment obsolete within a few years after purchase. Electronic and electrical waste is referred to as e-waste and some of it might be valuable as a source for secondary raw material, but also toxic if discarded improperly. Better management of e-waste is one of the focus areas of South Africa's National Waste Research, Development and Innovation roadmap.

PAGE 26

DETERMINING FRUIT TREE WATER USE

Researchers use micrometeorological instruments to find out how much water fruit trees use, and when. They also study the factors that affect water use and apply this information to promote better management, allocation and efficiency of water use in agricultural and forestry sectors. >

PAGE 25

EFFECTIVE WATER RESOURCE MANAGEMENT NEEDED FOR SOCIAL AND ECONOMIC WELLBEING

Sanny Moshwane sees for the first time what bacteria from fingerprints, which had been incubated in a growth medium on an agar plate, look like through a microscope set up by CSIR researchers in the Manok village near Burgersfort in Limpopo. To improve the uptake of technologies and interventions in communities, local residents are given the opportunity to interact with and learn from researchers. During this visit, the researchers demonstrated how bacteria, which are invisible to the naked eye, can lead to contamination. This project and other water security awareness campaigns are underpinned by CSIR research into water-related issues, for example the identification of the country's strategic water sources. ^

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Projections for regional climate change

Guiding policy and technology solutions

IN BRIEF

Climate change is a reality and primarily caused by human activities. This was the conclusion of the fifth Assessment Report of the Intergovernmental Panel on Climate Change released in 2014. The CSIR has been working on issues related to climate change for more than 20 years, and has made substantive contributions to this report. Researchers at the CSIR are producing scenarios on the effect of climate change in South Africa and Africa, interpreting the implications for the region and Africa, and guiding technology and policy responses.

THE CHALLENGE

Adapting to climate change and curbing the causes

Significant climate change has already occurred and further changes can no longer be avoided. Therefore developing adaptation measures is essential.

At the same time, a concerted and significant global effort is needed to curb the causes of climate change and hence to limit the scale of change that will occur. This is a particular challenge in South Africa, which has an energy-intensive economy dependent on coal.

Adaptation and mitigation will need to take place at all scales: from individual actions to those of cities, economic sectors and nations, and ultimately to international cooperative actions. The work of the CSIR covers adaptation and mitigation at scales from local government to international treaties.

RESEARCH

Observations and analysis

The CSIR is home to the leading capacity in climate change research, development and implementation in Africa. Following the 17th Conference of the Parties (COP17) to the United Nations Framework Convention on Climate Change in Durban, the CSIR was one of 11 organisations worldwide to form the Climate Technology Centre Network, a clearing-house and brokerage for climate change advice to countries.

The CSIR operates sensitive and advanced instruments measuring key aspects of the changing climate system in the southern African region: in the southern oceans, the savannas of Africa, and around areas of industry and habitation. The information from these sources is used by international teams of scientists studying the changing global carbon cycle.

The Southern Cape is a climatic transition zone between winter and summer rainfall regions. It is therefore particularly vulnerable to climate change impacts and already at the sharp end of natural disasters. Ecological mitigation is critical to help secure the region's food and water supplies.

The organisation has the expertise, sophisticated modelling systems and experiments to explore the impacts of those changes to ecosystems, water supplies, human health, industries, the built environment and agriculture.

The CSIR developed and maintains the South African Risk and Vulnerability Atlas on behalf of the Department of Science and Technology. This atlas is aimed at equipping decision-makers with information on the impact and risk associated with global change in the region.

OUTPUTS

Downscaled climate projections, assessments and policy guidance

Global climate models produce projections of climate change patterns at large (continental) scales and are often too coarse to be useful at the national and sub-national scale. Downscaled climate projections with the necessary detail for local purposes are produced by the CSIR and have featured in the Department of Environmental Affairs' Long-Term Adaptation Strategy, as well as in many sector-specific studies.

CSIR researchers have contributed to the highly influential work of the Intergovernmental Panel on Climate Change. The organisation has also provided advice regarding adaptation and mitigation to the national government and to several South African metropolitan municipalities (eThekwini, Cape Town and Johannesburg) and sectors such as agriculture, insurance, mining and energy.

OUTCOMES

Better-informed decisions

Long-term planning is dependent on reliable information about the effects of climate change. The CSIR contributes to a long-term planning process by clearly demarcating the threats and opportunities when they become reasonably clear and making this information available to decision-makers.

The ultimate purpose of the CSIR's work on climate change is to protect the present and future wellbeing of South Africans, by helping to keep the environment and all the species that share it, safe and healthy; and by ensuring that development and economic growth in South Africa take place in a sustainable manner.

Natural environment

DIFFERENCES IN VEGETATION-FIRE-CLIMATE RELATIONSHIPS AMONG CONTINENTS

The response of savanna vegetation to global changes in climate is likely to differ in Africa, Australia and South America. This is the finding of collaborative research published by the journal *Science*, in January 2014. Researchers used data from 2 154 sites in savannas across three continents to compare the structure and functioning of these ecosystems.

Although all three continents are broadly dominated by the same woodland-savanna vegetation, the way that rainfall, temperature and fire interact to structure these vegetation types is different, in other words, the systems function differently.

The paper demonstrates that the warmer temperatures predicted for the future are likely to increase the extent of woody cover in African savannas, but will slightly decrease them in Australia and South America. This could explain why bush encroachment is currently a serious problem in many African rangelands, but not in Australia.

These results complicate attempts to model future global vegetation and carbon stocks, and suggest that we should be particularly cautious when introducing tree and grass species from other continents (such as *Eucalyptus* from Australia) to African savannas, as it might fundamentally alter how our ecosystems work.

The impact and frequency of wild fires, such as this grass-fuelled blaze, depend on vegetation and climate factors.

PAIRED OCEAN GLIDERS TRANSECT THE SOUTHERN OCEAN TO COLLECT DATA

CSIR researchers simultaneously obtained Southern Ocean climate data from the ocean surface and ocean depths by launching two types of ocean gliders on a solo mission during the summer of 2013/14.

The Southern Ocean plays an important role in carbon dioxide (CO_2) exchange between the ocean and atmosphere. It is estimated that half of the man-made CO_2 absorbed by the oceans is taken up by the Southern Ocean, yet it is one of the least studied places on the globe.

Researchers paired 1 km-deep profiling gliders with wave gliders on the surface. The surface gliders measured the exchange of CO_2 and the atmosphere while the deep gliders collected data from the ocean depths.

Roughly 2 000 km away from Cape Town, these autonomous ocean robots sent back key climate observations to CSIR researchers via satellite. The use of robotic gliders has unlocked our ability to obtain observations of the physical and biological workings of remote ocean regions. Gliders can be launched for periods of up to six months, a substantial improvement on ship-based observations that are limited to a few weeks at a time.

The ocean robotics capabilities have been supported by the Department of Science and Technology and form part of a larger CSIR-led Southern Ocean Carbon and Climate Observatory.

SATELLITE DATA PRODUCTS USED TO STUDY ENVIRONMENTAL EVENTS

User-friendly satellite data products provided by the CSIR have enabled researchers to study various environmental conditions, ranging from the pollution of South Africa's freshwater sources to the exploration of phytoplankton blooms that cause marine events.

Satellites provide a unique capability to monitor oceans and inland water bodies by providing regularly updated data over vast areas at low cost. CSIR researchers use this data to produce maps, graphs and other user-friendly products, which provide critical information to stakeholders, such as environmental and maritime agencies, industry, government departments and other scientists.

The Department of Water Affairs, for example, uses satellite data to study conditions in dams and lakes to assess long-term changes in water eutrophication around the country. Eutrophication occurs when a body of water acquires a high concentration of nutrients that promote excessive algae growth. When the algae die, the decomposition process will use oxygen, and may lead to a reduction in the number of fish and other organisms. The eutrophication of freshwater ecosystems can be caused by runoff from agriculture, mining, pollution from dilapidated municipal sewers, and other human-related activities that increase the influx of both inorganic nutrients and organic substances into such systems.

The CSIR's satellite data products have also enabled researchers from the Aquaculture Directorate of the Department of Agriculture, Forestry and Fisheries to study crayfish walkouts in St Helena Bay in 2009 and 2012. They concluded that the crayfish walk-outs were the result of naturally occurring red tides.

The Department of Environmental Affairs (DEA) uses the data to assess the state of the marine environment by monitoring ocean temperature and the phytoplankton growth that supports local fisheries. CSIR researchers use satellite data to contribute to the development of a DEA Ocean and Coastal Information Management System. This system will guide the use of natural resources in the coastal zone to encourage social and economic growth while protecting the environment.

Several new satellites will be launched over the next 10 years, which will substantially improve researchers' ability to view the changing earth. The CSIR is preparing for the data that will become available from these satellites by developing algorithms, testing performance and putting processing capabilities into place.

Progressing towards a green economy

IN BRIEF

Creating economic growth and jobs through a resource-efficient and low-carbon development path is a national priority for South Africa. The CSIR, in partnership with the private sector and government, provides supporting research and development to contribute to green economy opportunities that can lead to sustainable employment while protecting our natural resources.

THE CHALLENGE

Managing natural resources while maximising jobs and addressing social needs

South Africa has a resource-intensive economy which is heavily dependent on fossil fuels such as coal and petroleum and is faced with declining natural resources such as water, soil and biodiversity, which can constrain our future growth prospects. A further challenge is South Africa's deepening inequalities. A global and national drive towards a green economy development path focuses on reducing the dependence of economic development on consumption and damage to our declining natural resources, while maximising jobs and addressing social needs and inequalities.

RESEARCH, DEVELOPMENT AND IMPLEMENTATION

Measuring progress

Supporting the green economy transition in South Africa requires a common understanding of how to plan, measure and monitor progress. CSIR researchers have developed a Green Economy Index, which provides a snapshot of overall progress toward a green economy. It offers a balanced and integrated picture of development, including human and environmental well-being, rather than a singular focus on gross domestic product. The index is based on 26 indicators measuring performance across social, economic and environmental dimensions. It serves as a baseline against which to measure progress, enables comparisons between countries and informs more directed planning for green economic interventions.

Unlocking development opportunities in the waste sector

Nationally, the waste sector is regarded as having significant opportunity for green jobs and economic growth. The CSIR and the DST are entering the third phase of development of the National Waste Sector Research Development and Innovation Road Map, which seeks to unlock the development opportunities within the sector. (Full story on page 26.)

Enterprise development in a recycling context

The CSIR completed a business plan for the recycling of off-the-road mining tyres for the Finsch Diamond Mine. It was submitted to the Recycling and Development Initiative of South Africa for approval. This recycling business could potentially represent an investment of R55 million in Danielskuil in the Northern Cape and could create 50 full-time job opportunities.

Green materials from waste

CSIR researchers are developing biocomposites from agricultural residues (maize stalk and sugar cane bagasse), with the aim of producing packaging materials and products for the automotive sector.

A green city

The CSIR, in partnership with the City of Tshwane Metropolitan Municipality and the United Nations Environment Programme, developed a framework for a green economy transition for this metropolitan area. The research team recommended that intervention and investment focus on green innovation and technology and the development of partnerships between government, business, labour and civil society.

Alternative land use

The CSIR, in partnership with Rio Tinto's Richards Bay Minerals, continued with a post-mining, alternative land-use programme during 2013. The programme focuses on agricultural and forestry plant species that can be commercially grown on previously mined land. The pilot farm is conducting trials and identifying technically viable crops, soil impacts and farming practice for different species.

The results from the pilot farm will indicate which plant species could be successfully cultivated, leading to the creation of sustainable jobs in agriculture following the closure of the mine.

Novel thermal and sound-insulation material from waste products

CSIR researchers have developed insulation materials using waste products for applications in building industries. The novel materials can perform a thermal and noise-absorption function simultaneously. The materials were obtained using fibres from waste plastic bottles and discarded sheep wool. (Full story on page 73.)

Breathing new life into the pulp and paper industry

The CSIR, in collaboration with the University of KwaZulu-Natal and industry partners, is focusing on making the pulp and paper industry more profitable and competitive through diversification. The typical yield in traditional chemical pulping is 50% of the tree, with the rest discarded as waste. By producing multiple products, a biorefinery takes advantage of differences in biomass components and maximises value from the tree by producing low-volume high-value chemical products, and low-value high-volume transportation fuel. Electricity and process heat for use in the plants can be generated, thus helping national energy needs, reducing production costs and reducing greenhouse-gas emissions.

Richards Bay Minerals has been mining coastal sand dunes in northern Zululand for more than 35 years. The support of the CSIR initiated a rehabilitation programme that focuses on agricultural and forestry plant species that can be commercially grown on previously mined land. The objective is to present the community with economic opportunities when the mined land is returned to them.

Planning for a secure water future

IN BRIEF

By managing our water resources effectively South Africa can support economic development and the social wellbeing of its people. CSIR researchers have provided inputs to global and national policies and guidelines for water resource development. This includes the mapping of South Africa's strategic water source areas and a contribution to an influential international publication that will guide global investment and management of the world's protected areas.

The Gouritz River's catchment stretches from the Karoo to the coast and is one of the largest in South Africa. The CSIR has been studying water quality and quantity in the area, involving specialists in water quality, human health, estuary management, hydrological modelling, resource economics, conservation and ecological infrastructure.

THE CHALLENGE

Lack of safe water can hamper development

Access to good quality potable water is not only a basic human right, but also the life source of South Africa's economy. Poor water management and uncontrolled development near strategic water sources can negatively affect water security with dire health consequences and an adverse effect on economic growth and development.

For South Africa to manage its water resources effectively, all sectors of society, from government to private sector, need information to inform decisions about natural resources in a development context.

RESEARCH AND DEVELOPMENT

Mapping strategic water sources

South Africa is a water-scarce country and it is therefore critical to understand where the country's strategic water source areas are and how they contribute to water supply. Strategic water source areas are those areas that supply a disproportionately high amount of the country's water in relation to their surface area. CSIR researchers used hydrological and run-off data to map these areas and completed a report to guide strategic planning for the protection of water sources. The key finding of the research was that the strategic water source areas make up only 8% of South Africa's land area, yet they provide 50% of our water. Only 18% of these areas are under some form of protection.

A key indication of the health of the country's water source areas is the extent to which its naturally functioning ecosystems are still intact. Uncontrolled development that involves, for example, the removal of natural vegetation for agriculture or built structures, can interrupt water flow, cause soil erosion and pollute water sources with a negative impact on the water quality and availability in those areas. These problems are of particular concern in strategic water source areas because the impact is transferred to the entire downstream system of water users, affecting water treatment costs, regional economies and human health.

Researchers found that the Free State and the Western Cape have the highest percentage of natural land cover remaining (95% and 76%, respectively) around their strategic water sources. Mpumalanga, KwaZulu-Natal and Limpopo have had almost half of their land cover modified.

Over half of the Mpumalanga, Drakensberg, Soutpansberg, Table Mountain and Zululand Coast strategic water source areas are modified. In Mpumalanga and the Drakensberg, this is mostly due to plantation forestry; for Zululand Coast the main cause was cultivation; urbanisation was the main contributing factor in the Table Mountain area, while cultivation and plantation forestry were the main causes in the Soutpansberg. Nationally, the spatial overlap of strategic water source areas with mining areas is not high, but two areas, Mfolozi Headwaters and Enkangala Drakensberg, have over 30% overlap, which means that they are particularly vulnerable to the impact of mining.

PROJECT HIGHLIGHTS

Natural environment

OUTCOME

Ecological infrastructure heeded in development decisions

The recommendation to politicians and decision-makers focused on the fact that strategic water source areas need to be protected as they form the ecological foundation on which South Africa's water services depend.

The map informed the selection of priority focus areas to guide the implementation of government's National Infrastructure Development Plan. It also informed government's National Water Resources Strategy which guides the implementation of the National Water Act at local scale.

A guide on global investment and management of the world's protected areas

Every 10 years the International Union for Conservation of Nature issues a publication that provides guidelines for global investment and management of the world's protected areas. CSIR researchers have contributed a chapter to the next edition focusing on managing freshwater, river, wetland and estuary-based protected areas. The researchers highlighted the importance of rivers and estuaries and the importance of coordinated freshwater and marine conservation.

The CSIR's participation in this important and influential international process recognises the leading expertise of CSIR researchers in the area of strategic conservation and development planning for aquatic ecosystems.

Access to clean and safe water is crucial for the health of all South Africans. CSIR researchers have identified and mapped South Africa's strategic water sources and are involved in awareness programmes, such as the WWF South Africa and Sanlam's Journey of Water campaign that focuses on the journey of water from river catchments to taps.

SIGNIFICANT WATER SAVINGS POSSIBLE IN FRUIT ORCHARDS

CSIR researchers have used sophisticated equipment in studies that showed that fruit farmers are able to achieve significant water savings without a reduction in yield.

The agricultural sector in South Africa is the biggest water user, utilising approximately 60% of the surface water resources of the country. There is a high dependency on irrigation, particularly for fruit and vegetable crops. However, with competing demands for water, there is a need to use less water for agricultural production, while maintaining existing levels of production. This necessitates improvements in water use efficiency.

The CSIR, in collaboration with the University of Pretoria, has concluded a seven-year research project commissioned and funded by the Water Research Commission and the Department of Agriculture, Forestry and Fisheries, in which the water use of some of the most important fruit and nut tree species in summer and winter rainfall areas of South Africa (i.e. apples, citrus, nectarines, macadamias and pecans) was quantified using intensive field measurements and modelling. This included the measurement of sap flow in fruit tree stems, weather variables, soil water fluctuations and total orchard water use.

Results for actual daily fruit tree water use data over an entire growing season indicated that significant water savings (between 6% and 30% depending on use of supplementary rainfall) were possible, without reductions in yield. In the Western Cape for example, researchers found that traditional irrigation guidelines were accurate for most part of the season, but that farmers could reduce irrigation towards the end of the season when deciduous fruit trees were losing their leaves and rainfall was increasing.

The findings can be used by farmers for irrigation scheduling and by catchment management agencies and irrigation boards for regional-scale water resource planning and allocation purposes. At national scale, they can be used for agricultural water-use modelling, water resource assessments and strategic planning purposes.

An Eddy Covariance system on a lattice mast in an orange orchard measures turbulent eddies of air above a vegetation canopy. These are important drivers of water vapour exchange from the underlying vegetation. Researchers use this and other equipment to measure the water use of fruit trees.

Too valuable to waste

A paradigm shift in thinking

IN BRIEF

South Africa disposes of most of the waste it generates in landfills. However, a global paradigm shift in waste and resource management, driven by issues of climate change, resource scarcity, carbon economics and energy security, has the potential to transform and grow a South African waste economy. CSIR researchers conducted an analysis of the South African waste sector and calculated the value of potentially recoverable resources lost to the economy through the disposal of waste.

Plastic waste is recovered at the Mfidikoe Buy-Back Centre located in the Bojanala Platinum District Municipality of North West. *(See article on page 28.)*

THE CHALLENGE

Resources lost through landfilling

CSIR research shows that about 90% of South Africa's waste is disposed of in landfills, partly because of the perception that doing so is cheaper than recycling or recovery. While traditional thought focused on the cost of waste management through removal and disposal, a shift in thinking is now exploring the immense value of waste as a secondary resource which is lost to the South African economy through landfilling. This raises questions as to how we can maximise the recovery of this value from our waste through increased reuse, recycling and recovery. While this has a direct economic benefit to the country, it also has an environmental benefit.

RESEARCH

Establishing a baseline

In 2012 the Department of Science and Technology commissioned the CSIR to develop the National Waste Research, Development and Innovation (RDI) roadmap. To ensure that the roadmap is based on sound evidence, the CSIR conducted two separate studies, the first to understand the scope and growth prospects of the formal

waste industry and the second to determine the economic benefits of moving waste away from landfilling towards recycling and recovery. The purpose of the research was to inform government and industry decision-making and strategic planning to ultimately lead to increased employment and enterprise development opportunities in the South African waste sector.

The size of the waste sector

The CSIR analysed the formal private and public waste sector for 2012 to establish a baseline of, among others, employment, distribution, turnover, and innovation activity against which to monitor future sector growth.

The study found that almost 30 000 people were employed within the formal waste sector of which almost a third were employed in the private sector. The private sector saw approximately 8.2% growth in employment since 2009, while the overall employment in the formal waste sector has remained largely unchanged.

The estimated financial value of the formal waste sector had increased from R10 billion in 2009 to R15.3 billion (0.51% of gross domestic product) in 2012. During this period private waste sector revenue more than doubled from R3 billion in 2009 to approximately R6.9 billion in 2012.

The private sector showed a higher level of innovation activity than municipalities, especially through the introduction of local and international waste technologies into the South African waste market. As a result, researchers concluded that the private sector is an important partner to support the transfer of new technologies into the municipal waste sector.

The value of waste

In the second study, CSIR researchers modelled different scenarios to determine the value of waste that could potentially be recovered and recycled back into the South African economy. The study estimated that, in 2012, the total value of this waste was approximately R25.2 billion of which only R8.2 billion was being recovered.

This is considered a conservative estimate of the resource value that is locked up in waste and which is currently lost to the South African economy, since the researchers did not include the potential additional value waste could have after recycling, for example in manufacturing, and the potential of job creation.

OUTCOME

Informing a South African waste roadmap

These and other reports have informed the development of the RDI roadmap for South Africa. The DST began the final stage in the development of this roadmap in January 2014, which is aimed at guiding government's investment in waste RDI over the next 10 years. Through stakeholder participation, five waste streams have been prioritised for action, namely: organic waste, municipal waste, plastic, tyres and e-waste (electronic waste).

Working on an international platform

International research partnerships are important to the successful implementation of the roadmap. The DST and the CSIR welcomed the opportunity to participate in building a joint European and African research and innovation agenda on waste management for 2014 to 2020. The agenda creates a platform for increased collaborative waste research, sharing of best practice, technology transfer and skills development.

Natural environment

Waste management contributes to a green economy.

RECYCLING IN NORTH WEST IMPROVES LIVES

A recyclable waste collection centre is improving waste management and creating employment opportunities in North West thanks to a partnership between the CSIR and the provincial government.

The Mfidikoe Buy-Back Centre is located approximately 14 km east of Rustenburg in the Bojanala Platinum District Municipality of North West. The recently launched centre is generating employment opportunities as a sustainable enterprise based on the collection, sorting and sale of recyclable waste. This includes paper, plastic, metal and glass. This enterprise is also enhancing the role and responsibilities of waste collectors in the surrounding communities by providing a local point-of-sale to individual collectors.

The establishment of the Mfidikoe Buy-Back Centre was the outcome of a partnership between the North West Department of Economic Development, Environment, Conservation and Tourism and the CSIR.

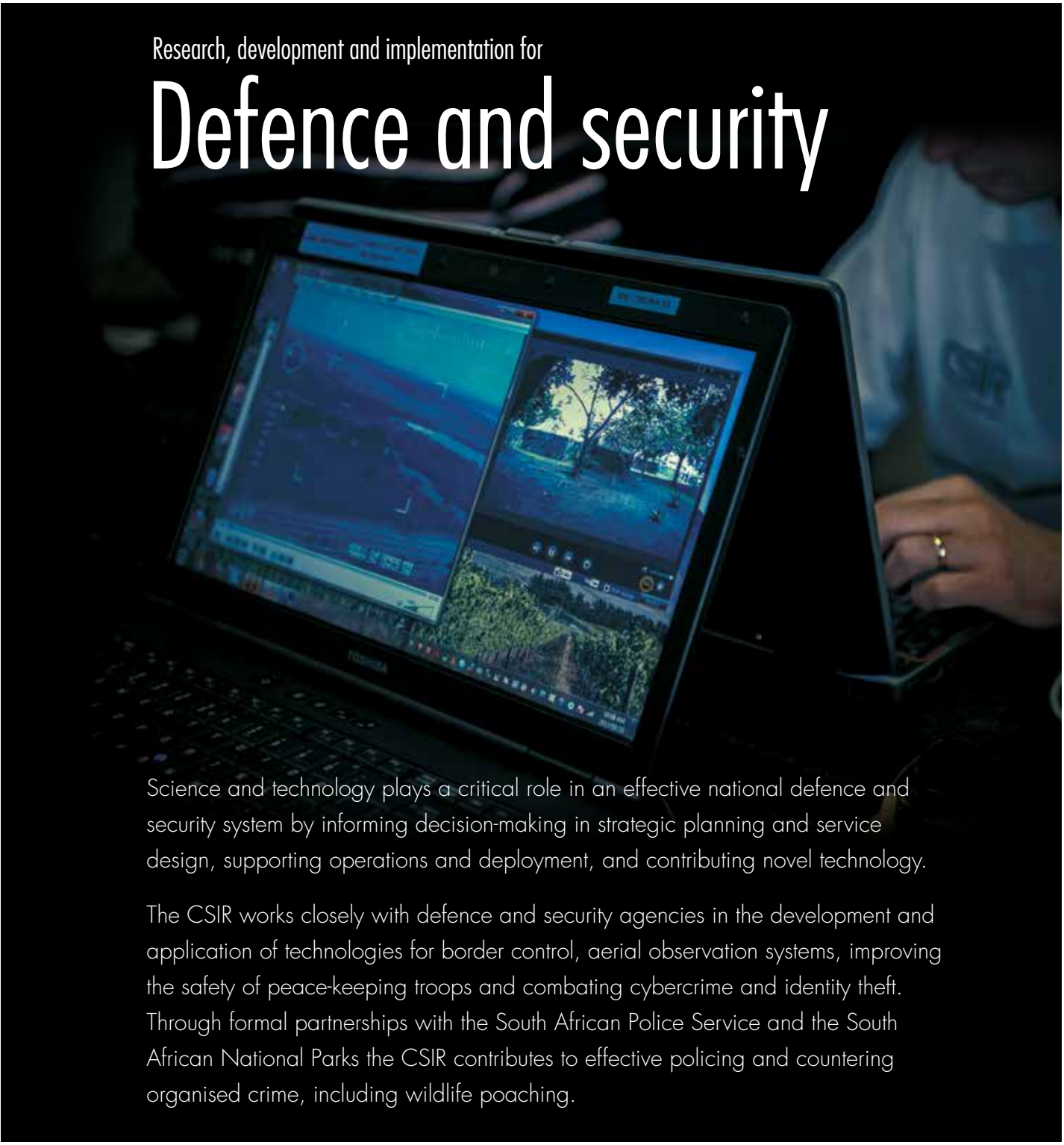
The project emphasises how waste management practices have become a more critical part of preserving the environment and are contributing to a green economy. It was developed and launched as an initiative to reduce pressure on South Africa's landfill sites by improving the level of waste management.

The CSIR assisted in renovating and improving the existing building facilities, ensuring legal compliance, sourcing the appropriate equipment and establishing the centre as a fully functional business enterprise. The Mfidikoe Buy-Back Centre employs five staff members who assist the waste collectors with the sorting and sales of the recyclable waste.

The project has demonstrated that small-scale local enterprises in the waste sector are both commercially viable and have the potential for long-term positive impact on the sustainability of our environment.

Research, development and implementation for

Defence and security



Science and technology plays a critical role in an effective national defence and security system by informing decision-making in strategic planning and service design, supporting operations and deployment, and contributing novel technology.

The CSIR works closely with defence and security agencies in the development and application of technologies for border control, aerial observation systems, improving the safety of peace-keeping troops and combating cybercrime and identity theft. Through formal partnerships with the South African Police Service and the South African National Parks the CSIR contributes to effective policing and countering organised crime, including wildlife poaching.

PROJECT HIGHLIGHTS

Defence and security

SIMULATION SYSTEM TO PROTECT SA AIR SPACE

A new CSIR-developed electronic warfare simulation system is used to characterise targets.

PAGE 38

OPTRONICS IN CRIME-FIGHTING SURVEILLANCE

CSIR scientists joined members of the South African Police Service (SAPS) in overnight anti-crime operations to demonstrate how advanced sensor and optronic technologies can assist in effective surveillance. In this instance aerial and ground-based systems, including night-vision capabilities and multi-platform communication systems, were used to assist the SAPS to monitor and raid a den of suspected criminals.

PAGE 34

MAKING FINGERPRINT SOFTWARE MORE ADAPTABLE

A screenshot of the CSIR-developed fingerprint analysis software. The software automatically extracts features from a fingerprint. These can be used to match the fingerprint to an identity. An additional tool has been developed to allow users to manually select features and compare these to the automatically extracted ones.

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PROJECT HIGHLIGHTS

Defence and security

SPECIALIST FACILITIES FOR RESEARCH INTO UNMANNED AIRCRAFT SYSTEMS

The CSIR's work in aeronautics is supported by world-class infrastructure such as a laboratory for research into unmanned aircraft systems, a centre to analyse computational fluid dynamics and a suite of wind tunnels. In wind tunnel testing, air flow is simulated over a static airframe, as seen in this photo taken in the 7m wind tunnel. Instrumentation in or on the supported test item provides the data with which the aerodynamic behaviour of the airframe is measured at different flow speeds. Research into unmanned aircraft systems also benefits from a high-fidelity flight simulator in which models are test-flown virtually. The modelling and simulation-based approach to the development of such systems is a cost-effective and efficient way to develop new concepts and technologies.

PAGE 36

UNDERSTANDING THE EFFECTS OF EXPLOSIVE IMPACT

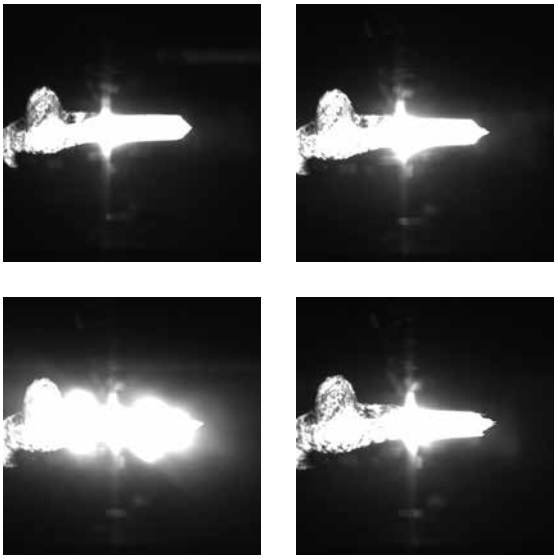
CSIR researchers install a newly developed surrogate lower leg, fitted with sensors, on measuring apparatus in preparation for an explosive test experiment. The CSIR undertakes testing of various explosive effects at its detonics, ballistics and explosives laboratory.

PAGE 38

ARGON GAS CREATES 'SUPER FLASH' TO LIGHT UP EXPLOSIVE EVENT FOOTAGE

Argon bomb detonation images taken six microseconds apart show the 'super flash' that is used to make targets more visible and easier to capture clearly during ultra-high-speed photography of rapid explosive events. The quality of footage from explosive experiments is critical for effective characterisation of the behaviour and effects of explosives. The CSIR undertakes research on explosives to develop better protection against blast attacks.

Researchers discovered that a 'super-flash' during the initiation of an argon illuminator provides adequate illumination for target photography up to a frame speed of 2 million frames per second. Argon is a gas often used in fluorescent lighting. >



Partnering for enhanced national safety and security

IN BRIEF

The CSIR has contributed to a safe and secure South Africa by establishing a number of important national partnerships. These include partnerships with the South African Police Service (SAPS) and the South African National Parks (SANParks). The SAPS receives support from the CSIR in order to expand and improve its technological ability. Similarly, SANParks is being assisted to improve its ability to safeguard game and other natural assets – and in particular a current priority to prevent rhino poaching. The CSIR's long track record in defence and safety-related work contributes to the success of these projects.

THE CHALLENGE

New crime threats call for new tactics

Law enforcement agencies are battling a growing scope of criminal activities; from conventional personal and property crimes, to modern day technology cybercrimes such as identity theft. Criminal activities also include piracy, poaching, urban unrest and trans-border syndicated crimes. The CSIR response is set to contribute to the aim articulated in Government's Programme of Action that "people living in South Africa feel and are safe and have no fear of crime".

The safety and security domain is one that involves a large number of responsible departments and agencies. There is an urgent need for greater integration between the various players to achieve more effective service delivery. This requires consistencies in policies and approaches as well as the systems and tools used by various agencies to act on their respective mandates.

RESEARCH AND DEVELOPMENT

Shared, smart defence and security

As part of its impact strategy the CSIR established a safety and security flagship programme to contribute to the prevention and combatting of crime through research and development. The flagship identified two main aims: a long-term goal to establish a national, integrated safety and security system involving multiple stakeholders; and the development of short-term engineering and technology solutions to improve selection, use and management of technology.

CSIR and SAPS in 'smart policing'

In 2013 the CSIR and the SAPS signed an agreement that creates the institutional framework that will allow the SAPS to access scientific, engineering and technology support. This will benefit both the operational and strategic components of the SAPS.

The agreement outlines a portfolio of research and technology support programmes over a three-year period.

Getting a better grip on crime and combat

Agencies in crime prevention need strategies to move from re-active

SAPS National Commissioner General Riah Phiyega and CSIR Chief Executive Officer Dr Sibusiso Sibisi at the signing of a Memorandum of Agreement that creates the institutional framework for the SAPS to access scientific, engineering and technology support from the CSIR to expand and improve its technological ability.

responses to more pro-active stances. They need to collect better and more reliable information, to analyse this information and to use the results to efficiently allocate resources and make better tactical decisions. This is possible through new means of surveillance and command and control centres designed to give an integrated picture of events.

A pilot project was started at the CSIR to establish such a centre. It draws on past experiences such as the large-scale national surveillance and safety operation undertaken during the Soccer World Cup in 2010. Contributing technologies include sensors and optronics, information and communications technology, geo-spatial content and, in particular, the means of linking different inputs into a greater and integrated system.

Adding CSIR muscle to fight rhino poaching

The poaching of rhino in South Africa – particularly from protected game reserves – has escalated dramatically in recent years. The value of rhino horn has lured well-organised criminal groups to become involved in poaching. The Kruger National Park is particularly vulnerable because of its location on the South African border.

In September 2013 the CSIR and SANParks entered into a partnership to help the Parks agency to make the best use of its surveillance and detection capabilities as well as increasing the effectiveness of its anti-poaching operations.

The CSIR will be drawing on its experience in border safe-guarding, sensors and surveillance, communication systems, as well as detection and tracking in these efforts. The initial programme requires hands-on operational experience in surveillance and detection, mobility and technologies used by specialist military forces. New interventions include means of detecting human movement; technologies to identify the origin of gunfire; and sensor technologies at poaching hot spots.

The longer-term objective is the establishment of a joint Environmental Asset Protection Office at the CSIR for the continued safekeeping of minerals and poached goods such as abalone and rhino horn.

Refining unmanned aircraft systems for effective detection from the sky

IN BRIEF

The use of unmanned aircraft systems is an attractive option for detecting and monitoring on-the-ground activities because it is safe, practical and economical. CSIR research on these systems serves to inform technology choices made by security and military agencies responsible for the safekeeping of vital zones or border areas. Researchers are testing the best combinations of unmanned aircraft and detection technologies. This includes novel airframe design, camera and sensor technology and data streaming of patrol footage in near real time.

THE CHALLENGE

Smart technology choices for effective airborne surveillance

Unmanned aircraft systems (UAS) comprise unmanned aircraft plus additional systems – some incorporated on the actual airframe (e.g. cameras, infrared detection systems) and others on the ground as a base station to and from which data are relayed. Since no pilot is required, UAS can be used to survey areas that are dangerous, or where tedious and routine patrol is required.

An 'eye in the sky' can also provide information on which to base preventative or rapid response action. Examples of such use could include: during unrest situations, illegal border-crossings or the poaching of rhino horn.

However, a myriad of airframes and technologies exist. Challenges faced relate to the flight time a vehicle is able to sustain, the stability of the surveillance collection system and the ability to fly undetected. The CSIR is involved in developing UAS to demonstrate the usefulness and limitations of such systems for surveillance. Based on the knowledge gained from these exercises, the CSIR can advise security agencies on the best options for the design and integration of existing UAS and the appropriate choice of new systems.

UAS in surveillance

Various models of unmanned aerial vehicles are available in the commercial market. CSIR research into UAS focuses on novel airframe design; means of sustained power (including the need for silent motors); and experimental integration of camera and sensor technologies. In some military environments there is a need for modular designs; use of light-weight materials; and the means to quickly assemble and dismantle.

One example of work undertaken is further refinements to the surveillance data capturing of the CSIR's Indiza system. Indiza is a rugged, mini UAS with a two-metre wing span that is launched by hand. A number of interchangeable camera pods can be fitted into the airframe, which also contains a GPS-based autopilot, radio modem and video transmitter.

A small engine test rig of an unmanned aircraft system is being developed and assembled with the assistance of Dutch intern students from the University of Applied Sciences in Amsterdam in the Netherlands. This rig has been designed to provide inlet air at similar atmospheric conditions to those from sea level to a 5 000 metre altitude. The long-endurance engine has been fitted and tests scheduled for 2014.

The ground-based equipment consists of a laptop-based mission planner and a data-link modem with a tracking antenna system for the video and data links.

The airframe can accommodate three different types of camera systems: a pan, tilt and twin-camera system; a high-definition, wide-angle video camera; and a 3G cell phone-based camera.

The CSIR has also undertaken further development of Denel Dynamics' cranked-wing Hungwe airframe concept to determine its use in territorial surveillance, for example, in anti-rhino poaching deployments. Optimisation of the airframe geometry and desired performance started in 2014.

CSIR researchers are also developing a modular UAS with longer endurance. This version utilises a small petrol engine for through-the-night duration capability and electric motors for up to an hour of quiet surveillance. A locally developed stabilised camera system is fitted to the central payload pod.

Contributing to further research on UAS

CSIR research is not only refining the optimal combination of systems for unmanned aerial vehicles, but also accruing knowledge to be shared with industry and other research entities. Through funding provided by the Department of Science and Technology – and with the aim of supporting local universities and industry – four systems were built. Two were earmarked for the Universities of Stellenbosch and Johannesburg and the remaining two are used at the CSIR for ongoing research into the performance of aircraft and as wind tunnel test vehicles.

Benefits to civil aviation skills development

The CSIR developed technologies for a medium-altitude, long-endurance system by integrating national research and testing efforts through the Civil Commercial Unmanned Aerial System project. The set of technologies for this system will in turn feed into the design and development of various unmanned aircraft vehicles.

PROJECT HIGHLIGHTS

Defence and security

DEVELOPMENT OF SURROGATE LEG HELPS RESEARCH INTO EFFECTS OF MINE EXPLOSIONS

The CSIR has developed a surrogate lower leg fitted with sensors that provide information on the effects of landmine explosions on humans. These sensors measure the damage sustained by tissue and bone in the leg and can also indicate the level of amputation that may be required.

The leg consists of rods made out of a type of polyester and specialised gelatine. The integrated sensors allow researchers to quantify the time taken for the shockwave to arrive at discrete points along the surrogate tibia bone. The information is then used to estimate the shock velocity and to identify where the most protection is required. Before the development of the surrogate leg, researchers had to visually inspect remnants of surrogate parts collected after a blast test.

The surrogate lower leg is one outcome of decades of research into the protection of humans against various forms of explosive events and weaponry. Further research, based on data generated through experimentation with the surrogate leg, will look at active mitigation, specifically the development of footwear that will be able to detect a possible explosion and counter its effects in real time.

NEW SIMULATION SYSTEM HELPS PROTECT SOUTH AFRICAN AIR SPACE

The CSIR has more than 50 years of experience with the development of electronic warfare systems for the South African National Defence Force. During 2014 the Enigma 4 system was completed. Enigma 4 is an electronic warfare simulation system used to characterise targets.

The Enigma 4 system is able to simulate signals on a radar system, as well as detect and characterise the radar signals it receives. If, for example, the South African Air Force (SAAF) requires an understanding of how the radar on one of its aircraft behaves under the influence of jamming, the system is used to simulate a realistic target on the aircraft's radar, while also injecting a jamming signal. The performance of the aeroplane's radar under these conditions can then be studied.

The technology is used by the SAAF and Navy, as well as local and international research institutes.

FINGERPRINT ANALYSIS SOFTWARE LICENSED

The CSIR has developed a fingerprint software development kit which consists of a collection of functions for performing various fingerprint image processing operations.
The technology was licensed to iPulse Systems, a South African company specialising in the design and distribution of biometric solutions.

The majority of the algorithms incorporated in the fingerprint software development kit were developed at the CSIR. The technology will enable fingerprint identification system developers to customise their systems – an option that is currently not available in existing commercial products. More specifically, the software will allow the user access to more output information, rather than simply being a black-box solution. They can then use this information to add further functionality, such as creating sub-classes within each fingerprint class.

The agreement forms part of the CSIR's strategy to provide strategic independence to South African high-tech enterprises by reducing their dependence on suppliers of foreign technology solutions. The development of the technology results from the investment by the Department of Science and Technology into the development of biometric competency in the country.

NETWORK EMULATION PLATFORM PROVIDES A SAFE MEANS TO TEST NETWORK VULNERABILITIES

The CSIR has developed a network emulation platform that acts as a testing environment for network and device security. The system is used for cybersecurity training, network modelling and advanced analytics to assist the private sector and government departments.

Networks – particularly those in large organisations or government departments – can easily be exposed to security risks due to poorly configured and unprotected network infrastructure. These security risks can expose organisations to attacks that may lead to the misuse of resources, allow unauthorised access to confidential data and the introduction of viruses and spyware programs.

Protecting networks against these threats can be extremely difficult, particularly if the different types of threats and the areas of vulnerability are not well-understood. The network emulator provides a platform for the high-fidelity replication of existing or planned networks. It has the capacity to generate real-time, network-aware traffic and to test various aspects of the network such as speed, performance, behaviour and security to determine the areas of greatest vulnerability.

By offering organisations the opportunity to adopt a comprehensive approach to network security, the platform plays an integral part in the evaluation and improvement of South Africa's corporate and government network infrastructure.

Research, development and implementation for Industry

South Africa's manufacturing sector plays an important role in stimulating economic growth, and hence in achieving our national goals of reducing unemployment and eliminating inequality.

The CSIR is contributing to the growth of the manufacturing sector by providing novel materials and technologies to small, medium and micro enterprises in biotechnology; identifying innovative uses of lasers for industrial processes; and supporting programmes to improve the energy efficiency of our large industries.

< CSIR researcher Thandeka Mhlanga investigates the behaviour of a laser light beam as it propagates in free-space. Work on lasers spans the entire spectrum across the research, development and innovation chain, from basic concepts to implementation in industrial systems.

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PROJECT HIGHLIGHTS

Industry

REVITALISING SA FOUNDRIES

Training interventions for scarce skills in South African foundries are creating development opportunities at leadership and artisan levels. South African foundries have been under pressure in recent years as a result of increased operating costs.

PAGE 51

BIOLOGICALS FOR INDUSTRIAL, VETERINARY AND HUMAN USE

A 20-litre fermenter is being prepared for the production of recombinant proteins in the CSIR process development laboratory. This laboratory plays a central role in the Biomanufacturing Industry Development Centre, established to help small enterprises bring more South African biotechnology products to market. >

PAGE 49

MANUFACTURING GIVEN AN EDGE WITH LASER TECHNOLOGY

The steel manufacturing industry routinely faces challenges pertaining to the wear and damage of high-value components used in production processes. A CSIR-developed laser cladding process is key in ensuring that the refurbished concast rolls of ArcellorMittal now last twice as long as before. ^

PAGE 47

PROJECT HIGHLIGHTS

Industry

PROPRIETARY PROCESSES

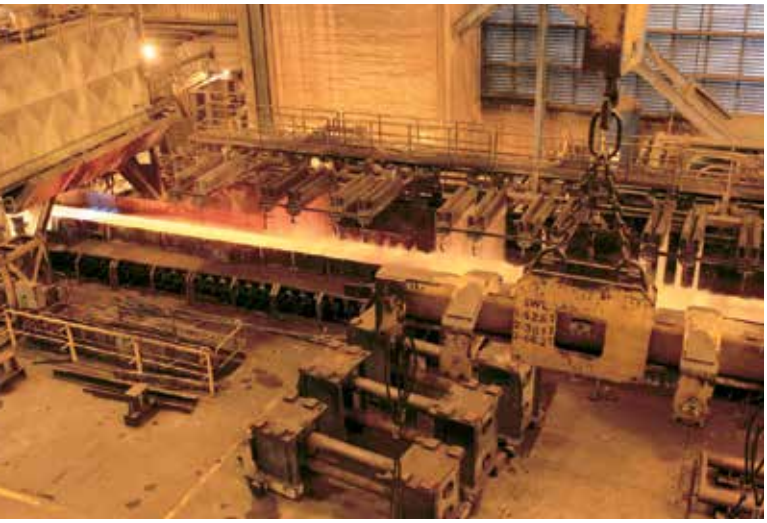
In determining beer's shelf life, researchers have developed a proprietary process that is conducted at very low temperatures. Here, a reactor is used during one of the preparation stages.

PAGE 52

MODELLING MINE VENTILATION SYSTEMS

Ventilation ducts with spiralling stiffening swages. These have been designed by a South African company for use in underground mines. Before being manufactured the CSIR used advanced mathematical modelling to confirm the energy saving capabilities of the new design.

PAGE 50



TOWARDS PRODUCING PRIMARY TITANIUM METAL

A panoramic view of the titanium pilot plant, which is seen as a step towards a commercial-scale plant that will be able to produce titanium powder at a much lower cost than current imports.

PAGE 50

INDUSTRY SUCCESS IN ENERGY SAVINGS

The production of hot-rolled coil steel at the ArcelorMittal Saldanha plant is extremely energy intensive and presented the ideal setting to realise one of industry's most significant energy savings to date, some R127 million in two years.

PAGE 51

Laser technology unlocks potential across the innovation chain

IN BRIEF

Lasers are well-established, but the continued versatility of this technology is being demonstrated by the work done at the CSIR. In addition to fundamental research on the digital laser, the CSIR has developed cladding technologies used in manufacturing.

RESEARCH AND DEVELOPMENT

Work on lasers spans the entire spectrum across the research, development and innovation chain, from basic concepts to implementation in industrial systems.

At the push of a button

Before the advent of the digital laser, the output beam from a laser was considered a pre-designed property, and implemented by custom mirrors. To change the design required physically removing the mirrors and replacing them with newly designed equivalents. With the digital laser it is possible to change the output beam from a laser at the push of the button. The digital laser allows the laser mirrors to become programmable, so that the output beam is also programmable – a world first, proven at the CSIR. This may have applications in telecommunications for encoding information on demand at the source.

Resonating with industry

CSIR scientists have demonstrated that a minor modification to a standard industrial laser system (the addition of two novel mirrors) increases the efficiency of the system by a factor of ten. The technology has significant potential and forms the basis of a new Technology Innovation Agency commercialisation project.

Helping industry stay at the cutting edge

The CSIR has over the past seven years developed a strong competence in laser-based refurbishment, based

Dr Angela Dudley (left) and Melanie McLaren in the laser laboratory, where Dr Dudley uses digital holograms to measure the fundamental properties of light. While there are many commercial devices to measure the particular properties of optical fields emerging from lasers and optical fibres, none are able to provide full information on the field. CSIR researchers have used rewritable liquid crystal technology to demonstrate the potential for an all-in-one diagnostic tool, capable of extracting all the key information. The ability to quantify these properties will allow users to monitor the optical performance of a system in real time, with uses in the fibre-optic industry and in photonics research.

on laser cladding technology. In this technology, a high-power industrial laser is used to generate a small puddle of molten metal (a weld pool) on the surface of a metal. New material in the form of a metal powder is injected into this weld pool. When the laser beam and powder injection system is traversed across the work piece, the metal surface and newly deposited layer solidify, creating a new layer of material. This new layer is metallurgically bonded to the base material, ensuring excellent adhesion of the new layer to the metal substrate. The cladded layer can be engineered by varying the material composition to increase the wear properties or corrosion resistance properties of the base material, and can also be used to rebuild damaged or worn surfaces. Due to the highly localised heat input, there is little distortion and no significant change in microstructure and associated material performance degradation away from the cladded layer.

This technology can be used to effectively repair worn or damaged equipment, such as press tools, trim tools, rotating shafts and journals, as well as any other mechanical components which have become redundant as a result of surface wear or damage.

During 2013/14 CSIR laser welding engineers have designed and constructed a mobile system based on this technology. It can be used to repair high-value components on-site. The system is based on fibre laser technology and couples the laser source to a mobile robotic delivery arm which handles the beam delivery and powder-feeding systems. As part of the industrial test and evaluation phase of the project, the team repaired high-value turbine components used in the power-generation industry at a local turbine engineering firm. The repair processes are developed and optimised, and test samples are produced and tested before the final repair process is approved and the welds implemented. The components repaired include a turbine blade carrier and the refurbishment of a turbine rotor. This capability allows the CSIR to offer specialised refurbishment services on large and high-value components in the power generation industry.

PROJECT HIGHLIGHTS

Industry

IN BRIEF

The CSIR has launched a three-year programme to provide technology and product development support to South African small, medium and micro enterprises (SMMEs) that use bioprocessing technologies in their manufacturing operations. The programme is supported by the Development Bank of Southern Africa (DBSA) through the Jobs Fund programme and by the Industry Innovation Support Fund of the Department of Science and Technology (DST).

The first three SMMEs selected have been enrolled in the programme, and are actively being supported by CSIR scientists and engineers. A further six enterprises will participate in the programme in the coming year.

Siyabonga Xaba monitors the fermentation process during the production of biological products in the CSIR process development laboratory. Xaba is an intern in the experiential training programme of the Biomanufacturing Industry Development Centre.

THE CHALLENGE

Translating knowledge into products and accessing the right infrastructure

South Africa has a history of excellent research, development and innovation potential embedded in educational institutions, science councils and the private sector. In the biotechnology sector, translation of this potential into value adding products has, however, been limited.

While progress has been made in establishing a nascent biotechnology industry, the translation of concept technologies to market-ready products and the establishment of manufacturing entities remain a barrier to the growth of this sector. Furthermore, a critical gap exists in the skills and infrastructure necessary to take biotechnology inventions through a product and process development phase to market-ready products.

The promotion of SMMEs is a key element in government's strategy for job creation, poverty eradication and economic empowerment.

An open-access facility to support biotechnology enterprises

In addition to being hampered by institutional barriers (such as access to finance, markets and managerial skills) SMMEs often also do not have access to the technical skills and infrastructure to develop their products and processes.

THE RESEARCH AND DEVELOPMENT

An open-access facility for biomanufacturing

The Biomanufacturing Industry Development Centre (BIDC) programme has been established to accelerate the translation of research and development (R&D) into market-ready products and technologies by addressing the gap in skills and infrastructure.

The programme offers support throughout the value chain, from laboratory-scale concept validation to pilot-scale validation and demonstration of biomanufacturing technology. This is possible as a result of significant investment in infrastructure, equipment and skills. Other important aspects of support to SMMEs are product prototyping and small-scale manufacturing support.

Hub for open-access in biomanufacturing

The BIDC programme provides companies with access to ready-to-use biomanufacturing facilities and supporting R&D laboratories. CSIR scientists and engineers work in close collaboration with these companies to ensure that products and processes are aligned with company requirements and meet the needs of the market. The companies retain ownership of their innovations and products. The model used in the programme lowers the cost and barriers to entry that inhibit innovative enterprises from translating their inventions into market-ready products.

Partnerships with business incubators such as eGoLiBio and The Innovation Hub provide business incubation support to SMMEs, while partnerships with initiatives such as the Technology Innovation Agency Bioprocessing Platform in eThekwini are aimed at expanding the reach of biomanufacturing support to other areas in the country. In addition to the provision of SMME support, the BIDC programme is working closely with existing businesses in the biomanufacturing sector to support their new product development activities. These businesses include BioVAC, Afriplex and Onderstepoort Biological Products.

Developing human capital for the biomanufacturing sector

A shortage of skills in bioprocessing and product development, as well as in biomanufacturing, hampers the development of this sector. The BIDC programme is developing a critical mass of bioprocessing skills through the recruitment and training of qualified scientists and engineers. A year-long experiential learning opportunity for young scientists and engineers provides the opportunity to develop hands-on skills and knowledge in biomanufacturing.

With entrepreneurs, trainees and skilled R&D professionals, the BIDC programme is expected to help evolve best practices in biomanufacturing and accelerate the growth of a biomanufacturing sector.

Industry

ADVANCED MODELLING OF UNDERGROUND VENTILATION SYSTEMS

The CSIR used advanced mathematical methods to confirm that the new design of an underground mine ventilation system would reduce energy costs.

When a Krugersdorp-based company designed a new underground mine ventilation system aimed at reducing energy costs, it needed to prove that it would do exactly that. The company realised that a systematic simulation would prove its new design's effectiveness.

The company approached the CSIR to conduct the advanced mathematical modelling required. Underground mine ventilation systems consist of long duct networks spanning several kilometres. These systems require huge amounts of electricity to drive fans that blow fresh air through the ducts. The company's new design included ventilation ducts with spiralling stiffening swages (stiffened pipes with spiralling grooved fittings). The design increases stiffness of the ducts while reducing frictional losses, resulting in a reduction in the overall electricity required to operate the ventilation fans.

The CSIR confirmed that the new design would achieve energy savings of between 3.5% and 13% when compared to current underground mine ventilation systems. As a result, the company is in the process of patenting its new design.

An energy-efficient duct for ventilation in underground mines.

A NEW ERA FOR SA TITANIUM INDUSTRY

The Titanium Centre of Competence has developed a suite of complementary technologies to help South Africa add value to its vast resources of titanium. The centre is hosted by the CSIR and funded by the Department of Science and Technology. A key component of this programme is the development and commercialisation of a novel process for producing primary titanium metal powder. To test this, a titanium pilot plant that continuously produces 2 kg of titanium per hour was built at the CSIR and officially opened in June 2013. Commissioning of the main part of the plant was completed in March 2014.

South Africa is the second largest producer of titanium-bearing mineral concentrate in the world. Apart from concentrating the mineral to produce titanium slag and pig iron, and producing some titanium-based pigment mainly for the local market, little further value is added to the mineral before it is exported. The titanium pilot plant is a key research facility in the quest to overcome the technical hurdles that stand in the way of South African beneficiation of titanium.

The development of a local titanium industry was given a further boost when the CSIR signed a memorandum of understanding with US-based aerospace company Boeing. The agreement covers joint research into using titanium powder in industrial manufacturing.

Titanium is critically important to Boeing in that 15% of a 787 airliner is made of this metal. The titanium process has the potential to eventually produce material for manufacturing some of the components of Boeing's aircraft more efficiently and cost effectively.

MASSIVE ENERGY SAVINGS REALISED IN INDUSTRY

Companies in energy-intensive industrial sectors are being assisted in the implementation of energy-efficiency interventions in a bid to reduce operating costs, the demand on the electricity grid and greenhouse gas emissions. By March 2014, energy savings realised through the Industrial Energy Efficiency (IEE) Project had reached R214 million (246 GWh) in 45 industry plants. In addition, the first companies who participated in the programme achieved certification in the international standard for energy management in early 2014.

The IEE Project is implemented by the National Cleaner Production Centre South Africa which is hosted by the CSIR on behalf of the Department of Trade and Industry. The holistic approach taken by the project equips industry professionals with industrial energy-efficiency skills through its training programme, developed in partnership with the United Nations Industrial Development Organisation. A total of 123 experts have been trained to date.

As part of their training, experts must implement energy-management systems and energy systems optimisation interventions in host plants. The IEE Project team works with the experts to develop case studies and share the results with industry on various platforms to encourage uptake of industrial energy-efficiency.

An example of the project's success is the ArcelorMittal Saldanha steel works in the Western Cape, whose energy manager attended the first expert-level training and implemented an energy-management system which has saved the plant R127 million to date.

Other success stories include two automotive component manufacturers that are among South Africa's first International Standard Organisation 50001 certified companies – two Tenneco plants in the Eastern Cape and Johnson Matthey South Africa in Gauteng, whose energy-management system realised R7.8 million in energy savings in the first year.

SA FOUNDRIES SECTOR RECEIVES MUCH-NEEDED SUPPORT

South African foundries (metal casting factories) have been under severe pressure in recent years, largely due to high operating costs, including substantial increases in energy costs. In 2012 the local foundries industry experienced a contraction of greater than 10%. The Department of Trade and Industry (**the dti**), has prioritised interventions for foundries, and 2013/14 saw a number of important human capital-related developments, including the launch and establishment of the Gauteng Foundry Training Centre and the New Foundry Generation Forum.

The National Foundry Technology Network – a **dti**-funded programme hosted by the CSIR – established and launched the Gauteng Foundry Training Centre at the Ekurhuleni East Training College in 2013. Its goal is to address the critical shortage of artisan melter, moulder and pattern maker skills. In January 2014 the first intake of 20 learners began their training. The plan is to expand the training capacity of the centre and to conduct feasibility studies for the establishment of similar centres in other parts of South Africa.

The New Foundry Generation Forum is a training and networking forum for younger leaders (aged between 25 and 45 years) selected from the foundries industry. Through courses, technology demonstrations and presentations, and in collaboration with key partners, the forum equips and empowers participants to play a stronger role in revitalising the South African foundries industry.

Industry

BREWING INDUSTRY USES INNOVATION TO PREDICT THE SHELF LIFE OF BEER

A reliable process to produce a key reagent that is used to predict the shelf life of beer is increasingly used by local and international breweries.

The reagent, α-phenyl-*N*-*tert*-butylnitrone (PBN), is used during an analytical technique called electron paramagnetic resonance and is used to measure the resistance of beer to free-radical oxidation. Typically, all beers contain a certain amount of naturally occurring antioxidants that protect their quality. Beverages with increased levels of natural antioxidants are resistant to the oxidation process for longer periods and thus the beverages are stable for longer periods.

By predicting the shelf life of the beverage, the beverage producer can determine the product's useful retail life within the commercial environment, leading to improved logistical planning and profits. The robust PBN process developed by the CSIR yields a high-quality product which has been taken up by the brewing industry.

CSIR researcher Dr Greg Gordon prepares a reagent used to predict the shelf life of beer.

The microfluidic cartridge of the Cellnostics device. The CSIR has developed this diagnostic tool that uses microfluidic technology to analyse blood samples at clinics in remote locations. Microfluidics involves the manipulation of very small amounts of fluid. The device can reduce the time between tests and diagnosis and subsequent treatment in resource-constrained areas which are located far from laboratories.

Research, development and implementation for Health

Access to good quality health care is a basic human right. The CSIR is supporting the delivery of quality health care by designing and adapting technologies to improve diagnosis and treatment in under-resourced areas; and by conducting fundamental research that will reduce the burden of diseases that have a disproportionate effect on the poor.

PROJECT HIGHLIGHTS

Health

‘GENE KISSING’ IMPACTS GENE ACTIVATION

Human DNA is made up of chromosomes, which occupy distinct territories within the cell nucleus (depicted here in red, green, blue and yellow). Looping appears to bring genes close to each other, enabling them to touch or ‘kiss’. CSIR researchers used DNA nucleases – referred to as molecular scissors – to cut DNA at precise locations to prevent them from making contact. This resulted in these genes not being able to be activated or to make RNA. Researchers showed that gene kissing is a cause, and not simply a consequence of gene activity.

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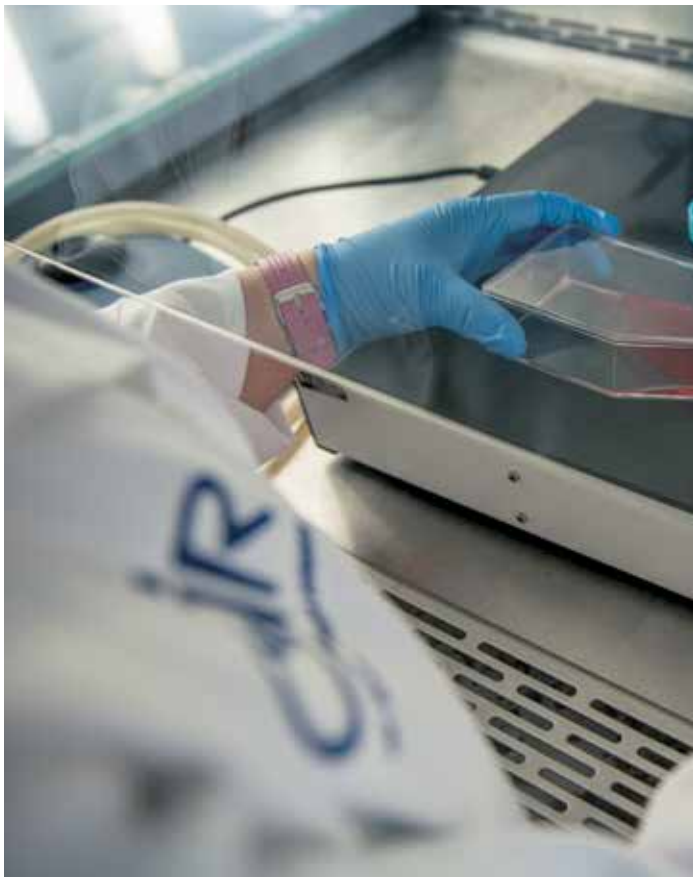
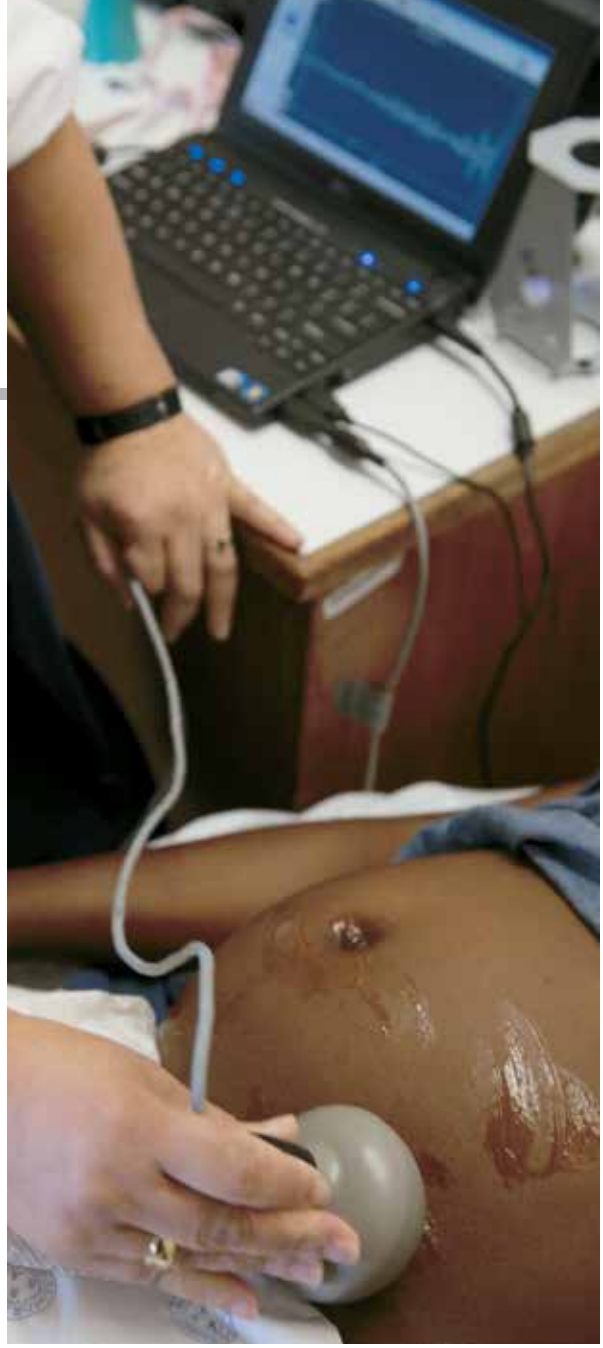


POOLING SKILLS TO FIND COMPOUNDS FOR MALARIA DRUGS

A researcher uses a pipette to draw blood from a container. This will be transferred to a plate for viewing under a microscope as part of research to support the development of a cure for malaria.

PAGE 61



FIELD TESTING OF AN ULTRASOUND DEVICE FOR PRIMARY HEALTH CARE

A health worker uses the Umbiflow ultrasound device in a primary health care facility. Umbiflow assesses umbilical blood flow and indicates whether a fetus that appears to be small for gestational age, is either small but healthy or small and sick. The patient could then be referred to a specialist. This testing is now possible in primary health care, thanks to technology which the CSIR helped to develop.

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PROJECT HIGHLIGHTS

Health

FIRST HEALTH CARE INFRASTRUCTURE NORMS AND STANDARDS GUIDELINES GAZETTED

The CSIR's Katekani Ngobeni, an environmental health practitioner in the field of building science, Tobias van Reenen, airborne contamination control and ventilation specialist, and Nsindiso Hlatshwayo, an architectural engineering technician, show the Government Gazette in which the first three sets of new national norms, standards, guidelines and performance benchmarks for health care facilities were published early in 2014. The CSIR also developed a facility assembly scheduling tool kit – software that helps authorities to give clear and consistent briefs to consultants, such as architects, by establishing total infrastructural and equipment needs at a facility in response to population size, disease profile and specialised services provided.

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TEST RESULTS ON TABLET

A tablet view of test results obtained from the Cellnostics image analysis software. The CSIR has developed the Cellnostics diagnostic device, which uses microfluidic technology to analyse blood samples in remote locations. The software allows medical practitioners to access the results from their cell phones or tablets.

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Umbiflow gives primary health care an edge

A health worker enters patient details ahead of an Umbiflow assessment of umbilical blood flow.

IN BRIEF

CSIR researchers have developed a simple, yet effective, Doppler ultrasound device called Umbiflow that can determine, at the primary point-of-care, whether a fetus that is small for gestational age is healthy or potentially sick. In 2013 a field trial was conducted in the Western Cape to measure the operational effectiveness and economic impact of the device and to assess whether its use in a primary health care setting has the potential to reduce the unnecessary referral of pregnant women for specialist care.

THE CHALLENGE

Reducing neonatal deaths

South Africa's mortality rate for children under the age of five is still more than double our Millennium Development Goal of 20 deaths per 1 000 live births. HIV/Aids, poverty and health-resource constraints are contributing factors. The country's eighth *Saving Babies Report* (2010 – 2011), published by the Medical Research Council (MRC), found that the top causes of perinatal deaths in the state health sector included labour-related complications, such as birth trauma, spontaneous pre-term birth and placental problems. A significant percentage of these deaths were found to be avoidable through more timely and appropriate health care interventions. Reducing infant mortality is a government priority and the associated challenge is to improve access to scarce resources for specialist obstetric care for those who need it, while reducing unnecessary patient referrals.

Fetal size is used as a simple metric to assess the health of a fetus during pregnancy and concerns are raised whenever a fetus is smaller than expected. By measuring blood flow in the umbilical cord, the Umbiflow device detects when the placenta is no longer providing sufficient nutrients and oxygen for the baby to reach its growth potential. This information can guide primary health care givers in their

decision about whether or not to refer a patient to specialist care.

Currently a clinic-based nurse must refer all patients where fetal growth restriction is suspected, to a higher level of care. At this stage a conventional Doppler ultrasound test is done using an expensive commercial instrument. This procedure requires the services of a trained sonographer, and South Africa is currently experiencing a shortage of this particular skill. According to the *Saving Babies Report* some of the top avoidable causes of baby deaths are delays in referring patients for specialist care and fetal distress not being detected by fetal monitoring.

RESEARCH AND DEVELOPMENT

Medical community gives Umbiflow the green light

Umbiflow was jointly developed by the MRC and the CSIR with inputs from Stellenbosch University Medical School, Tygerberg Hospital, Western Cape Provincial Clinicians for Obstetrics and Gynaecology, as well as the University of Cape Town's Health Economics Unit. The CSIR is the technology development partner and produced the ultrasonic probe, as well as the application-specific software while the MRC was instrumental in setting up the original user requirement and assisting with the clinical testing.

In 2013 a field trial was conducted in the Western Cape to measure Umbiflow's operational effectiveness and economic impact. The trial attracted great interest from the medical community and the preliminary trial results were shared at the *Priorities in Perinatal Care Conference* held in Cape Town in March 2014. Two oral presentations on the research were also given at the South African Society for Obstetricians and Gynaecologists.

The results of the trial showed that referrals of patients with suspected intra-uterine growth restriction can be reduced by 43% if the Umbiflow technology is made available at the primary care level. This figure can rise still further if ongoing monitoring of such cases is also carried out at the primary level. The study also investigated whether conducting an Umbiflow measurement on patients who only enter the antenatal care system in their third trimester was of value and this also achieved positive results with several cases of intra-uterine growth restriction that would otherwise have been missed, being diagnosed through Umbiflow.

OUTCOME

Inclusion in a WHO compendium for innovative medical devices in low-resource settings

The technology was accepted by the World Health Organization (WHO) forum for medical devices in the 2013 *Compendium for innovative medical devices in low-resource settings*.

The results of the field trial are currently being used to improve the Umbiflow system and, once estimations of the cost benefits are complete, the system will enter its commercialisation phase. Benefits demonstrated in the field effectiveness trial have confirmed the positive value of the technology and the CSIR and the MRC will now work with provincial and district health departments to open up the option of using the technology in primary health care settings.

A field trial in Mamelodi, outside Pretoria – to study efficacy and clinical significance in terms of impacting perinatal mortality in a large randomised trial with an unscreened population – is in the planning stages and will be a collaborative study with the University of Pretoria's Department of Family Medicine.

Diagnosing patients remotely

A CSIR researcher connects a tube to the microfluidic cartridge of the Cellnostics device, a diagnostic tool that allows doctors to perform basic blood tests in remote areas.

IN BRIEF

Diagnostic tools are an important part of any medical intervention – they are required to identify the presence and cause of disease, to suggest potential treatments and to monitor the effect of any interventions. Access to these tools is a challenge in parts of South Africa's public health system. The CSIR has assisted in addressing this challenge by developing a device that performs fast and effective blood test analyses.

THE CHALLENGE

Improving diagnosis in under-resourced areas

The majority of South Africans receive their medical care at public primary health care facilities, such as clinics and community centres. The services rendered at these facilities may include the ordering of blood tests and the results of these tests form a critical part of diagnosis and treatment for many conditions and illnesses.

If the health care centres are located far from centralised laboratories, the delays caused by the transport of blood samples and test results may detrimentally affect the quality of patient care.

RESEARCH, DEVELOPMENT AND IMPLEMENTATION

Efficient, wireless diagnosis

A multidisciplinary team of CSIR researchers developed a device, called Cellnostics, to perform quick and effective on-site blood tests to reduce the time between tests and diagnosis and subsequent treatment. The portable, wireless blood analyser has an embedded electronic device that allows for two-way communication between the clinic and a central laboratory. A medical professional can also access the information by means of different cellular technology devices, such as cell phones and tablets.

Cellnostics uses microfluidic technology to prepare blood samples for analysis.

Microfluidics involves the manipulation of very small volumes of fluid, typically at the nano- to femto-litre levels. Holography and other novel optical techniques record physical information from the blood samples prepared by the microfluidic cartridge.

The embedded electronics are designed to accommodate the considerable processing workload for data analysis, which is at the heart of this diagnostics system. The wireless functionality allows for remote access to the database and image analysis software. The medical professional, who can process results, images and any additional information from a clinic or another remote location, is therefore always kept in the loop.

Key collaborators include the National Health Laboratory Services; South African-based companies, Stone Three Venture Technology (Pty) Ltd and Retief Krige Industrial Designers; and a manufacturer specialising in microfluidic technologies based in Germany, Chipshop.

RESEARCHERS STEP UP THE FIGHT AGAINST MALARIA TRANSMISSION

In a renewed effort towards the eradication of malaria, a local research consortium has established the capacity to test – in advanced infection models – compounds which researchers hope could disrupt the life-cycle of the disease-causing parasite. Over the next two years, they will test thousands of compounds provided by local South African researchers, as well as compounds and compound libraries obtained from companies abroad. A number of these compounds are already undergoing early- to late-stage clinical development.

The group, known as the Gauteng Gametocyte Consortium, wants to develop drugs that work on novel metabolic or biological processes in the gametocyte – the sexual stage of the parasite – to minimise the potential for future drug resistance. The consortium has also established collaborations with researchers who look at other life stages of the parasite, for example when it develops in the mosquito prior to being transmitted to humans. To date, the consortium has established a knowledge base in Gauteng consisting of molecular biologists, entomologists, analysts, chemists and biochemists, as well as accompanying laboratory infrastructure.

The consortium consists of the CSIR, the University of Pretoria and the University of the Witwatersrand, while the researchers work in close collaboration with researchers at the National Health Laboratory Services and various leading groups within South Africa and organisations abroad. The project is funded by the Medical Research Council and the Medicines for Malaria Venture.

SA researchers show that some genes 'kiss' to switch each other on

IN BRIEF

In a ground-breaking discovery that will have a major impact on our understanding of the function of DNA, our genetic blueprint, a group of scientists in South Africa were the first to show that gene activity is a consequence of genes engaging in physical contact in three dimensions, also known as 'gene kissing'.

THE CHALLENGE

Is gene activity the cause or the consequence of physical contact?

In each of the about 10-trillion cells in a human body lies an incredible 1.2 metres of tightly coiled DNA. Due to this tight compaction, regions of DNA are permitted to touch or 'kiss'. Coded in DNA, are genes that determine our physical traits, such as eye colour or blood type. However, DNA also codes for genes that function constantly to keep us alive. These need to be switched 'on' and 'off' by the cell as needed.

How gene activity, or transcription, is regulated has been the subject of intense study for many years, and scientists have suspected for some time that the physical contact between genes, or 'gene kissing' could play a role.

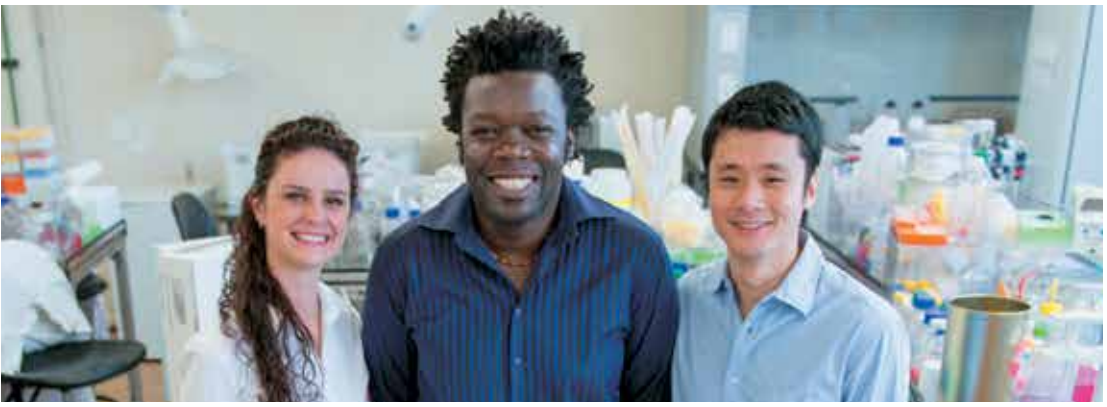
To address this fundamental question requires the ability to peer into the highly crowded environment of the nucleus and observe the interaction of genes in this way. To visualise these events requires state-of-the-art microscopes, sophisticated ways of labelling RNA and DNA, as well as cutting-edge technology that allows the discrete disruption of these interactions. A handful of laboratories in the world have both the equipment and expertise to conduct this type of research.

THE RESEARCH AND DEVELOPMENT

Genes are switched 'on' when they 'kiss'

A long-standing question in biology is whether genes are switched 'on' when they interact, or 'kiss'. This question was answered when a CSIR gene expression and biophysics team together with collaborators at the University of the Witwatersrand, performed ground-breaking experiments to show that 'gene kissing' can switch genes 'on'.

The state-of-the-art microscopes, custom-built in South Africa by the CSIR, were an important tool for imaging 'gene kissing' interactions. As these microscopes are able to achieve single molecule resolution, they are able to detect the activity of a single gene. Then using DNA nucleases – nicknamed 'molecular scissors' – the team was able to cut DNA at precise locations to prevent genes from making contact.



Dr Stephanie Fanucchi, a cell biologist, Dr Musa Mhlanga, molecular biophysicist and Dr Youtaro Shibayama, a microbiologist, have published ground-breaking research on gene interaction.

Researchers have designed these scissors to cut at regions in DNA where genes are 'kissing'.

This experiment revealed that when researchers cut sites where genes were interacting, those genes were no longer able to be activated or make RNA. This enabled researchers to confirm that the site where genes interact is critical for their regulation.

THE OUTPUT

New knowledge and tools on how genes behave

This landmark discovery was published in a paper titled: *Chromosomal Contact Permits Transcription between Coregulated Genes*, which appeared in the journal *Cell*. This paper is only the fifth South African-affiliated article to be published in *Cell*. The research gives scientists across the globe new knowledge and tools about how genes behave and how to direct them, paving the way for future discoveries.

OUTCOME

The fundamental nature of this observation has broad implications for how scientists understand gene regulation. Many diseases are due to aberrant gene regulation and activity. Therefore, these findings have far-reaching implications for science's understanding and treatment of cancer, chronic diseases such as diabetes, allergy responses and a host of other diseases and important cellular processes.

FIRST HEALTH CARE INFRASTRUCTURE NORMS AND STANDARDS GUIDELINES GAZETTED

The CSIR supported the national Department of Health in addressing serious challenges in the acquisition, quality, delivery, operation and maintenance of public health care facilities. The organisation helped develop new national norms, standards, guidelines and performance benchmarks for all levels of health care facilities.

In February 2014 the first three sets of these norms and standards guidelines were published in the Government Gazette – for building engineering services; infrastructure design for waste management in health care facilities; and emergency centres. These pertain only to the building of new public sector health facilities.

Multidisciplinary task teams with clinical and built environment expertise developed guidelines and tools to assist decision-makers and planners to determine cost estimates and time-lines for their health care capital works projects. This includes a decision-support tool used to project expenditure during the life-cycle phases of any category of health care facility.

Research, development and implementation for the

Built environment

South Africa requires continued investment in, and maintenance of, its social infrastructure to remain competitive and to sustain the growth of our economy.

The CSIR is supporting the built environment by collaborating in the implementation of the Strategic Integrated Projects of the National Infrastructure Plan; by providing the technical expertise that will underpin the next generation of road infrastructure; by demonstrating the economic benefits of innovative building technologies; and by contributing to the maintenance and efficient operation of our vital ports infrastructure.

< *South Africa's economy relies on a vast road network. The CSIR is part of a team that was commissioned by the South African National Roads Agency Limited to comprehensively revise and update the South African Road Design Method.*

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PROJECT HIGHLIGHTS

Built environment

TESTING ROAD MATERIALS AND DESIGN

Road deformation and cracks, spray-painted for clarity here, show the impact of repetitive loading pressure applied by a heavy vehicle simulator.

PAGE 72

TESTING SHIP MOORING AT PORTS

Researchers conduct small-scale physical model tests of the motion of container and bulk-cargo ships to determine mooring line forces, fender design and operational downtime based on wave conditions within harbours.

PAGE 68

PROTECTING HARBOUR INFRASTRUCTURE

CSIR researchers build three-dimensional physical scale models of harbours and their surrounds in a modelling hall at its coastal and hydraulics laboratory. It includes model breakwater structures, such as this one, to test the design against the impact of waves, tides, currents and storms. This helps to highlight weaknesses in structures, designs and systems before construction starts. Potential problems can then be investigated and minimised, thereby reducing the risk of damage to actual structures later. The physical model shown here was used to study the planned widening of the Durban harbour channel.

PAGE 68

Keeping South African ports safe and efficient

IN BRIEF

The health of our economy is dependent on our ability to trade – as part of the global economy we need to sell the goods and resources we produce to other countries, and in turn we need to import goods and resources that we cannot produce ourselves. Almost 90% of South Africa's international trade moves through our ports, and inefficiencies at these ports can constrain our economic growth. Research conducted at the CSIR is contributing to the maintenance and improvement of our port systems, as well as to the construction of new port facilities.

THE CHALLENGE

Staying competitive and sustainable

South Africa's economy depends on international trade and its eight main ports – Cape Town, Durban, East London, Mossel Bay, Ngqura, Port Elizabeth, Richards Bay and Saldanha – are gateways to over 90% of South African trade.

South Africa's ports have to handle increasing volumes. Between 2009 and 2013 the total volume of cargo moving through our ports increased from 183 million metric tons to 214 million metric tons. In addition, our ports need to be able to handle ever-increasing ship sizes; enable faster turnaround times; and ensure safe entry, docking, loading, unloading and departure. A further consideration is the need for these facilities to be designed and operated to minimise the impact on the natural environment.

RESEARCH AND DEVELOPMENT

Safer, more efficient ports and coastal infrastructure

CSIR research is making ports safer, more efficient and more sustainable.

The CSIR conducts research for local and international clients by modelling ports, breakwaters and harbours at its coastal and hydraulics laboratory. This facility allows researchers to build both mathematical and physical models of ports and their associated structures. It is the only modelling facility of its kind in Africa.

Coastal engineers use the facility to model and study the impact of proposed port developments; to determine how coastal structures will withstand the constant assault of wind and water; and to study the effect of sand mining in estuaries. Recent local studies at the facility include investigating the widening of the Port of Durban entrance channel; the simulation of moored vessels for the proposed new Durban dig-out port; and numerical model simulations of the loading and unloading efficiency of vessels moored at the Port of Ngqura, north-east of Port Elizabeth.

Real-time harbour monitoring: An everyday benefit

The CSIR monitors South African ports and harbours and the surrounding coastal environment to provide guidance on coastal maintenance and safety.

Harbour operators use the Integrated Port Operations Support System, a CSIR-developed web-based programme, for wave and wind monitoring. The system was developed in collaboration with the National Ports Authority and integrates data on a number of environmental parameters, including waves, currents, tides, water quality and wind. The system provides real-time, online information to port control duty officers.

At the national level the CSIR continually monitors South Africa's coastal environment to predict storm surges. Researchers are then able to warn port authorities of potential extreme wave actions, oil spills and coastal erosion in order to mitigate damage.

The East London main breakwater with dolos protection. The structure is approximately 600 metres in length from west to east at the mouth of the Buffalo River. Each dolos consists of 20 tons of concrete. The CSIR carries out annual monitoring surveys to assess the stability of the breakwater for Transnet.

Helping government with social infrastructure construction using

innovative building technologies

The Myra Primary School in Taung in North West was completed using innovative building technologies. The structures against this wall form part of an off-grid sanitation system.

IN BRIEF

The increased use of innovative building technologies (IBTs) in constructing schools, student residences, clinics, early learning centres, and houses can assist government to meet its service delivery obligations. The intention is that these technologies will be used in 60% of state-commissioned social infrastructure within three years.

To optimise the use of these technologies, government has contracted the CSIR to investigate the potential efficiencies that will accrue from the use of IBTs in the construction of schools and student residences and to compile guidelines on their use.

THE CHALLENGE

Using IBTs correctly within three years

Government is committed to using IBTs in the building of 60% of social infrastructure within three years. The CSIR was asked to analyse, compare and validate the time, costs and performance of IBTs when used in the construction of public buildings such as clinics, schools and student residences.

RESEARCH

Local results on IBT performance of social infrastructure

IBTs use a more manufacturing-based approach to building and construction than traditional methods. Most IBT building systems, products and components are manufactured in a factory and assembled on site. This improves performance because quality control can be done properly under factory conditions, and less time is needed on the construction site.

The CSIR found that the use of IBTs reduces construction costs by about 40% on average in South Africa and that construction times are reduced by up to 35%.

The CSIR has developed an IBT rating tool to select certified systems based on the best building performance, logistics and climatic conditions. The tool scores building performance aspects such as acoustics, thermal performance, comfort, fire resistance, condensation, moisture exclusion and durability. The logistics assessment takes into account location, terrain, speed of erection and distance from supplier. The climatic assessment includes the system's response to temperature, humidity and precipitation. These scores are then weighted in accordance with the performance requirements of a specific building occupation, for example, schools, and an overall score is produced.

OUTCOME

Uptake in 30 schools

The CSIR has developed guidelines for the use of IBTs and these are being used in the construction of 30 schools, with a value of close to R1 billion. CSIR researchers are assisting the Independent Development Trust in procuring and briefing professional service providers, IBT suppliers and contractors with a view to minimising construction risk. The IBT rating tool has been applied to identify the best IBT system for each school.

WHAT ARE IBTs?

IBT is a general term used to refer to a range of innovative building technologies. These systems generally do not use conventional brick and mortar but make use of framed panels fabricated off-site and assembled on site.

Built environment

TOWARDS BETTER ROAD DESIGN IN SOUTH AFRICA

The South African Road Design Method (SARDM) forms the backbone of road design in South Africa and most of southern Africa. The CSIR is part of a team that was commissioned by the South African National Roads Agency Limited (SANRAL) to comprehensively revise and update the SARDM.

The new SARDM will enable national, provincial and municipal governments to properly design and effectively maintain and protect road networks, which are essential to regional integration, economic growth and social development.

SANRAL is finalising the development of the SARDM software, which integrates some novel and world-leading CSIR technologies. One such a technology provides insight on the asphalt layers required for different roads. Asphalt layers are often the most expensive component of road construction and maintenance work. It is therefore important for road designers to optimise the thickness of asphalt layers while taking into account the supporting road structures and the expected axle/tyre loading and tyre contact stresses. A CSIR-developed system that simultaneously measures the vertical, transverse and longitudinal contact stresses under a moving wheel load supports such decisions.

Mr Louw Kannemeyer, SANRAL's network manager for national roads, and the CSIR's Dr Morris De Beer discussing the updating of the South African Road Design Method at SANRAL's headquarters.

TRAFFIC SIMULATED ON ROADS AROUND THE WORLD USING SA INVENTION

The heavy vehicle simulator (HVS) is a CSIR-developed testing facility for roads. By using the simulator, users can estimate the effect of 20 years of traffic flow on a road within a three-month period. The HVS is being used in numerous countries, with the latest orders from South Korea, Mexico and Saudi Arabia.

Roads are expensive to build. Before embarking on a large-scale road construction project using an unconventional design or with innovative materials, it is possible to build a short stretch of road and to test the effect of traffic using the heavy vehicle simulator. This enables the responsible authority to see how the road's structure and materials will perform over its lifespan and to make the appropriate modifications before construction starts.

The HVS has earned more than R220 million in foreign revenue since the technology was licenced to Dynatest in 1994. The HVS was developed more than 40 years ago and has undergone continuous improvements.

Fifteen HVSs have been sold internationally while South Africa has two locally. The biggest HVS ordered to date – requested by the Federal Aviation Administration of the USA – will simulate aircraft use for airport runway and taxiway design.

Dr Doice Moyo oversees the production of a novel thermal and sound-insulation material from waste products. The dual insulator mat is suitable for use in the building industry.

NOVEL THERMAL AND SOUND-INSULATION MATERIAL FROM WASTE PRODUCTS

CSIR materials scientists have developed insulation materials using waste products for applications in building industries. These novel materials can perform thermal and noise-absorption functions.

Using fibres obtained from waste plastic bottles and discarded sheep wool, the CSIR team developed thermal and noise-absorption insulation materials that are cheaper and more effective than alternatives currently available on the market.

The insulation material currently used by most building contractors does not contain noise. This has created a demand for better sound-absorbing materials suitable for buildings. Controlling noise pollution in hospitals, homes, shopping malls and offices helps to improve quality of life. Proper insulation furthermore ensures that the energy required to heat a building during winter and cool it during summer is minimal, directly reducing electricity costs.

The insulators take the form of a mat, needled together in a three-layer sandwich structure with air gaps between the fibre layers. These air gaps assist in trapping both heat and sound waves. Recycled polyester fibres are used in outer layers and waste wool fibres in the middle layers.
The fibres comply with the product requirements of the South African building industry.

Research, development and implementation to attain a

Digital advantage

Information and communication technology is a catalyst for socio-economic development and economic growth. The goal of the National Development Plan is that by 2030 South Africa will be a dynamic and connected information society with a vibrant, inclusive knowledge economy.

The CSIR is contributing to the vision of an inclusive information society by developing a novel technology that will facilitate the delivery of broadband to under-served areas; by participating in the development of the national broadband strategy; by supporting the information networks used by our tertiary institutions and research agencies; and by assisting our major metropolitan areas in their aim to become 'smart cities'.

< *Mainframe servers at the Centre for High Performance Computing, based in Cape Town. The centre is geared towards assisting large projects of national importance, such as the Square Kilometre Array.*

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PROJECT HIGHLIGHTS

Attaining a digital advantage

CENTRE WINS INTERNATIONAL STUDENT CLUSTER COMPETITION

Team South Africa scooped top honours at the international Student Cluster Challenge in 2013. South Africa, a first-time entrant, out-performed seasoned competitors from the USA, China, Germany, the UK and Costa Rica. The Centre for High Performance Computing was the organiser of the national round of the competition at which the top six students were chosen for the international challenge. The challenge is designed to introduce the next generation of students to the high performance computing world and community. Participation in the competition is contributing to the growth of expertise in high-performance computing in South Africa. In addition to contributing to national economic development initiatives these skills will be used in our large science projects such as the Square Kilometre Array.

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BROADBAND ACCESS FOR ALL

Learners of the Zenzeleni Primary School in KwaMhlanga, Mpumalanga, access the internet using the Broadband for All (BB4All) wireless mesh network during a computer literacy class. This school is used as a BB4All gateway for the cluster serving the Nkangala District Municipality. The BB4All project also makes use of the a novel tool to change the way frequency is allocated.

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POTENTIAL BROADBAND GAME-CHANGER

CSIR researchers Litsietsi Montsi and Luzango Mfupe work on the geo-location spectrum database tool, which allows mobile operators to check for and utilise unused spectrum in the television broadcasting frequencies.

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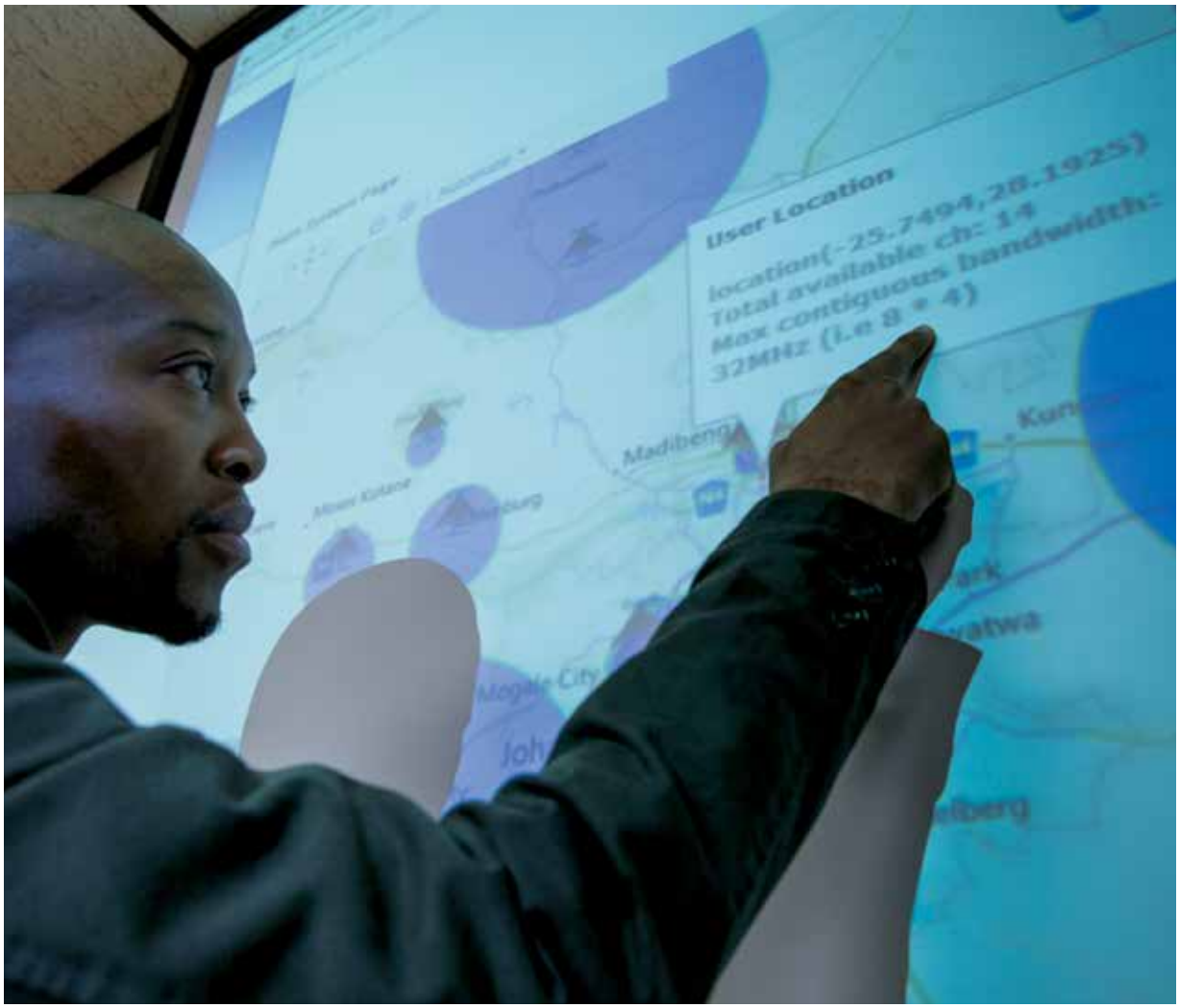
PROJECT HIGHLIGHTS

Attaining a digital advantage

IN BRIEF

The CSIR has developed a novel tool with the potential to change the way frequency spectrum is allocated, managed and regulated globally. The tool will allow wireless network operators to check for and utilise unused spectrum in the television broadcasting frequencies and hence facilitate the cheaper delivery of high-speed broadband networks in underserved areas. A successful trial of the tool, in partnership with Microsoft, laid the foundation for the development of a regulatory framework for dynamic spectrum use in South Africa.



CSIR researcher Litsietsi Montsi describes the operation of the geo-location spectrum database tool. The tool has been used successfully in a trial undertaken in partnership with Microsoft.

A novel tool set to change frequency spectrum allocation, management and regulation

THE CHALLENGE

Repurposing unused broadcast frequencies

Spectrum is the range of all possible frequencies that can be used for modern wireless and mobile communication, including voice, data and television. It is a finite and often expensive resource. Companies that have been allocated spectrum by the Independent Communications Authority of South Africa can pay up to R40 million a year even if they are not using it. Despite the cost, wireless network operators have campaigned very hard to be allocated further spectrum to build new networks using long-term evolution technology.

It is against this background that the CSIR has investigated using the television (TV) white space bands for further spectrum to deliver broadband internet access. Unused spectrum in the very-high frequency (VHF) and ultra-high frequency (UHF) bands is referred to as TV white spaces. These bands can carry communications signals at longer distances and are not easily affected by obstacles like trees and walls. Such bands would make the building of communications networks far cheaper because fewer base stations would be needed to repeat the signals over long distances.

However, wireless operators cannot use these frequency bands today because they exist in the spectrum reserved for TV broadcasting, even though most are not allocated to any TV broadcaster. Yet, it would be possible for wireless network operators to share these bands with broadcasters if they were available, and if they could prove that the technology used would not interfere with TV broadcasting in adjacent channels.

RESEARCH AND DEVELOPMENT

A tool to repurpose TV spectrum without interference in adjacent channels

Until recently it was not possible to check which allocated broadcast frequencies are not in use. Even if it were possible to identify broadcast frequencies not in use, no technology existed to allow for the unused broadcast frequencies to be repurposed for other forms of communication.

Sharing of TV white spaces requires dynamic spectrum access, meaning techniques and methods of reusing the same spectrum without any signal 'collisions'.

The CSIR has developed a tool that can assist a secondary spectrum user (for example a wireless network operator) to make an enquiry to determine whether spectrum is available for use at a particular location and time. The tool is able to check channels used by primary spectrum users (TV broadcasters) and regulate the signal strength of a secondary user so as not to interfere with other primary users. This tool is called a geo-location spectrum database.

This tool is being put to use in a TV white spaces trial that is being conducted in partnership with Microsoft and the University of Limpopo in the Mankweng area. The tool is the only one on the continent, with the CSIR holding the sole user rights.

Attaining a digital advantage

SUPPORTING THE CITY OF JOHANNESBURG TO BECOME A WORLD-CLASS SMART CITY

The CSIR has developed a smart city strategy and implementation plan for the City of Johannesburg. The strategy and implementation plan map out how the metro should integrate and leverage data from its disparate information management and enterprise planning resource systems in a cost-effective manner. Furthermore, the strategy outlines how it could harness information and communication technology to make its critical infrastructure and services easier to access and use.

Under its Growth and Development Strategy 2040, the City of Johannesburg has detailed its strategy to deliver equitable services, address poverty and unemployment, and transform Johannesburg into a world-class city. The smart city concept is a key pillar in this endeavour. Information and communication technologies allow active citizenry through digital engagement, two-way information sharing and efficient management of infrastructure.

The CSIR continues to provide expert advice on smart city strategies to the Development Bank of South Africa; the metropolitan municipalities of Cape Town and Tshwane, The Innovation Hub, and the Gauteng Department of Infrastructure Development.

MORE CAPACITY FOR SOUTH AFRICA'S RESEARCH NETWORK

The CSIR finalised an agreement to procure more international bandwidth capacity on the West Africa Cable System as part of a national initiative to ensure that South African researchers successfully participate in global knowledge production.

Since its inception in 2006, the South African National Research Network (SANReN) programme has connected 151 research and higher education sites – including the Southern African Large Telescope and Square Kilometre Array radio telescope sites – to the national backbone of the South African National Research and Education Network.

The procured capacity for SANReN is four times more than the current capacity of 10 Gigabits per second. The additional capacity, funded by the Department of Science and Technology (DST), will supplement the capacity already made available to beneficiaries of SANReN via SEACOM by the Tertiary Education and Research Network, the CSIR's partner in implementing and operating the network.

SANReN is a DST-funded project under the stewardship of the CSIR.

CONTRIBUTING TO A NATIONAL BROADBAND POLICY AND STRATEGY

The CSIR assisted in developing a broadband policy for South Africa. The policy was approved in December 2013.

The aim of the policy is to support the National Development Plan's vision of a wide-spread communications system, accessible across the country at a cost and a quality that meet the communications needs of citizens, businesses and the public sector. It is envisioned that such a communications system will allow for the creation of a wide range of application and services that are key for economic and social participation.

Dr Sibusiso Sibisi, CSIR Chief Executive Officer, was appointed as Chair of the National Broadband Advisory Council to advise on the implementation of the broadband policy and strategy. The council consists of independent technical experts and representatives from business, trade unions and civil society.

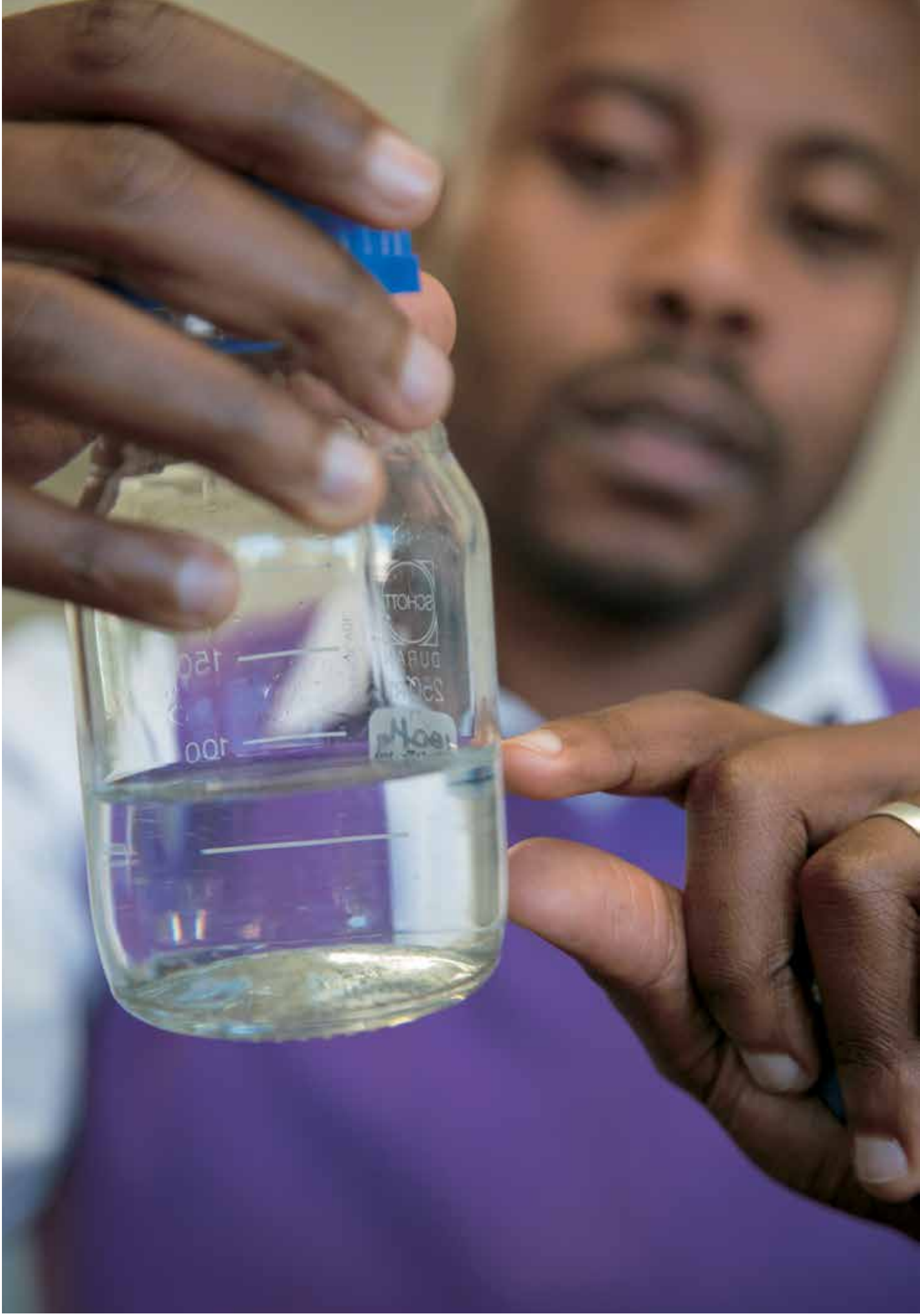
In addition the CSIR was appointed as the coordinator of the Strategic Integrated Project 15, which focuses on expanding access to communications technology. The organisation also participates in departmental working groups and uses its expertise in specific areas, such as dynamic spectrum allocation and decision support to resolve technical problems.

COMPUTING TO HELP ASTRONOMERS DETAIL THE SKIES

The Centre for High Performance Computing (CHPC) has made significant progress in ensuring that world-class computing services are available to users affiliated with international science and technology projects, such as the Square Kilometre Array (SKA). The SKA project is an international effort to build the world's largest radio telescope.

The radio telescopes of the SKA will collect and process vast amounts of data. A science data processing consortium was formed to ensure that all the computing requirements are available to efficiently store and analyse the incoming data. The CHPC joined Cambridge University and Daresbury Laboratories, both of the United Kingdom in this consortium.

The centre will also contribute to the development of exascale computing prototypes. One exaflop is the completion of 1 018 operations per second. These computing speeds are required to process data produced by the SKA and support science applications that will be run by local and international researchers affiliated with the SKA.



Research, development and implementation for Africa

South Africa continues to contribute towards African Union priorities by supporting socio-economic development initiatives in the region and the continent.

The CSIR is contributing towards this initiative by providing science and technology support to our continental partners. This support includes the expansion of satellite-based fire-detection systems, the development of local agro-processing industries, the upgrading and monitoring of transport infrastructure and the implementation of environmental management policies.

< Melusi Thwala is an environmental scientist who specialises in aquatic health at the CSIR nanotechnology sustainability laboratory. The CSIR studies the behaviour of nanomaterials and what eventually becomes of them after they are released into the environment. This is needed, as while there is a proliferation of industrial applications and consumer products containing nanomaterials, not much is known about the inherent risks associated with these products. At the 6th Society of Environmental Toxicology and Chemistry Africa Conference Zambia in 2013, CSIR researchers and their African counterparts established a working group to investigate the potential risks associated with nanotechnology relevant to the continent.

PROJECT HIGHLIGHTS

Africa

FIGHTING FIRES

A firefighter cools down the dying embers of a fire that caused severe devastation in an urban settlement in South Africa. With the CSIR's Advanced Fire Information System, authorities across southern Africa can receive timeous warnings of wildfires endangering people, natural vegetation, infrastructure and animal life.

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HELPING MALAWI TO ASSESS OVERLOADING

Michael Roux, a CSIR civil engineer, with a portable scale used in axle load surveys in Malawi, where the extent of overloading on roads were studied and control strategies updated.

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SHARING ESSENTIAL OILS KNOW-HOW

Essential oils are high-value products that find application in the fragrance industry worldwide. Staff members from the Ugandan Industrial Research Institute received training in South Africa on the cultivation and processing of essential oils.

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Africa

HELPING ENSURE ENVIRONMENTAL MANAGEMENT IN THE ANGOLAN OIL AND GAS SECTOR

An oil rig off the coast of Angola.

CSIR experts participated in a number of scientific studies and are providing their input to assist Angola with the decommissioning of oil fields.

The oil and gas sector in Angola has been active for over five decades. Oil concessions and wells have been exploited, and in some instances, oil fields in the more mature markets in the region are now reaching the end of their operational life spans.

Legislative requirements compel oil companies to develop decommissioning and abandonment plans. The purpose of these plans is to make sure that floating and underwater oil field structures are not a source of pollution, a threat to marine life or a shipping hazard.

The studies include environmental impact assessments, environmental management plans and the investigation of artificial reefing. The studies draw on extensive experience in working in the Angolan offshore marine environment and a wealth of scientific research data obtained over two decades.

The CSIR completed an impact assessment study for a floating production, storage and offloading vessel, which reached the end of its operational life. The study incorporated international best-practice techniques in terms of oil field abandonment while also devising novel abandonment methods suited to the Angolan context.

ASSISTING MOZAMBIQUE TO CREATE CAPACITY IN ROAD RESEARCH

A road outside Maputo, Mozambique.

Mozambique is in the process of establishing a road research centre in Maputo and the CSIR is playing a key role in this project. The overall objective is to improve the Mozambican capacity to undertake relevant, high-quality research relating to the road sector of the country.

The establishment of such a centre will not only address local road engineering problems and the development of appropriate norms and standards, but also create a strong foundation of science, engineering and technology to support local human capital development in this domain.

The initiative is sponsored by the United Kingdom's Department for International Development through its Africa Community Access Programme (AFCAP). AFCAP is addressing the challenges of providing reliable access for poor communities, giving advice and undertaking research to facilitate the delivery of safe and sustainable access.

DOCUMENTING THE STATUS OF AFRICA'S EAST COAST

Fishermen return home after fishing at sea off the coast of Tanzania.

CSIR researchers are participating in a study that will provide a comprehensive baseline on the status of the coastal and marine environment in the Western Indian Ocean (WIO). The WIO borders Africa's east coast and includes the ocean areas of Somalia, Kenya, Tanzania, Mozambique, South Africa and the islands of Madagascar, Comoros, the Seychelles, Mauritius and Reunion. The local team joined forces with scientists from other WIO regions to draft the WIO Regional State of the Coast Report.

The report documents the region's socio-economy, fisheries, biodiversity and human activities. It highlights the opportunities provided by the region's coastal and marine resources to sustain the development and livelihood of the coastal communities and countries of the region.

The CSIR was tasked with documenting human activities in the coastal and marine environment, as well as contributing on topics of coastal mining, desalinisation, coastal development, the management of river catchments, land use and human capacity development.

TURNING ESSENTIAL OILS CULTIVATION INTO PROFIT IN UGANDA

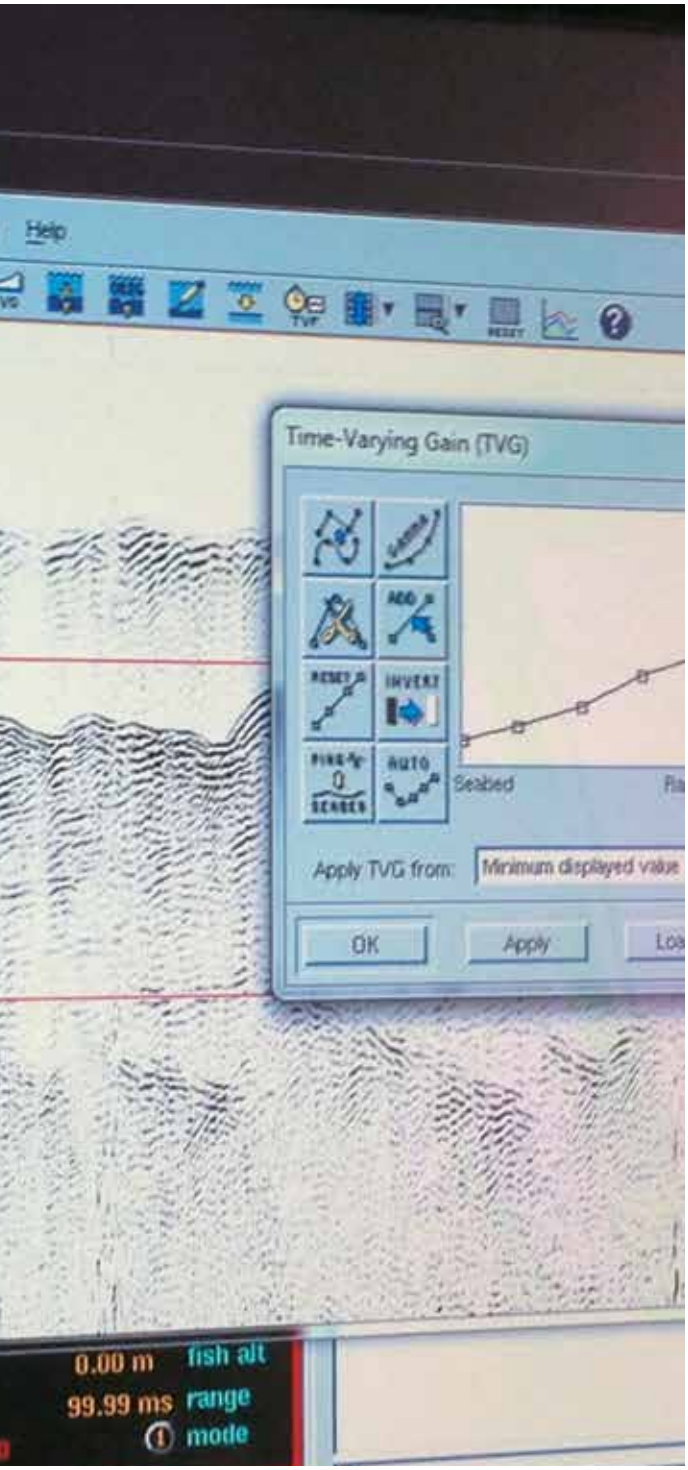
A distillation unit installed at the essential oil pilot project near Kampala, Uganda.

The CSIR collaborated with the Ugandan Industrial Research Institute to develop the essential oils sector in that country. The institute and the CSIR implemented an essential oil pilot project near Kampala. The project is contributing to the diversification of Uganda's agrarian sector to help boost employment.

Five high-value plants are used in this pilot, namely: rose geranium, sweet marjoram, hyssop, lemon balm and roman chamomile. A distillation unit (designed and constructed in South Africa) was installed for extraction of the oils, which will be used in the food, pharmaceuticals, fragrance, beverages, and cosmetic industries.

Production data obtained from the pilot operation phase of the project will determine how the cultivation sites are expanded. The final phase involves the capturing of the learning obtained during implementation to facilitate information dissemination in the agro-processing sector in Uganda.

Africa



Data acquired during the survey at Port Harcourt in Nigeria in preparation for the building of a new access channel to the port.

SURVEYING PORTS AND COASTAL REGIONS IN AFRICA

Monitoring of incoming data during a survey of the ocean floor in the Port of Walvis Bay in Namibia, undertaken by the CSIR for Namport.

The CSIR coastal engineering and port infrastructure group completed a number of surveying projects in Ghana, Nigeria and Namibia.

Ghana

The CSIR contributed to a prefeasibility study for a new jetty to be built in Ghana. The jetty will be used for importing clinker and gypsum to a cement factory in Aflao, Ghana. The near-shore coastal fieldwork included surveys aimed at creating images of large areas of the seafloor, characterising the layers of sediment and rock under the seafloor, securing samples of the seabed and monitoring the tides.

Namibia

The CSIR was contracted by Namport to conduct a survey to map the ocean floor for a new tanker berth to be developed in Namibia at the Port of Walvis Bay. With this development, the port will play an even bigger role as a Southern African Development Community (SADC) gateway to markets in Botswana, Zambia, Angola, Malawi and other SADC countries. The berth will be linked to the shore by an above-water trestle and the structure of the berth will be reinforced concrete that will most likely require deep-piled foundations. Plans include dredging a new access channel from deep water to the new berth.

Nigeria

At Port Harcourt in Nigeria, the CSIR completed a hydrographic survey as part of the planning process for the building of a new access channel to the port. The survey included mapping the seafloor and the identification of objects such as wrecks and other obstacles in the channel that may have an impact on the dredging works.

ASSISTING MALAWI TO ADDRESS HEAVY VEHICLE OVERLOADING

Staff at the Malawi Road Traffic Directorate undertake an axle load survey at Chileka on the road between Lilongwe and Mchinji on the border between Malawi and Zambia.

The overloading of goods vehicles is a problem in many countries and Malawi is no exception. Uncontrolled and widespread overloaded goods vehicles cause premature deterioration of the road network and impact negatively on road safety. CSIR transport systems and operations experts were appointed to update the Malawi axle load control strategy as part of an intervention to deal with the overloading problem.

The project is part of a European Union-funded initiative providing technical assistance to the road sector in Malawi. The main purpose is to assist Malawi's Road Traffic Directorate to conduct a nationwide survey to accurately assess the extent of the overloading problem on the road network. The current *Vehicle Weights and Axle Load Control Strategy* will be reviewed and updated based on the outcome of this survey.

CSIR researchers trained some 50 staff members to undertake axle load surveys. Preliminary analysis using axle load data up to April 2014 shows that about one-quarter of goods vehicles in Malawi are overloaded. These vehicles are on average overloaded by 2.5% (an average of 760 kg per vehicle).

FIRE INFORMATION TOOL TAKEN UP BY MORE AFRICAN COUNTRIES

A handheld device showing the Advanced Fire Information System software.

The CSIR has signed a memorandum of understanding with the University of Energy and the Natural Environment in Ghana to extend its Advanced Fire Information System (AFIS) to West Africa. The agreement follows similar agreements with Kenya and Angola.

AFIS is a satellite-based fire information tool that is able to detect, predict, monitor and assess fires globally. Once a fire has been detected, the system alerts relevant authorities of the potential danger via mobile-based text messages. A new application for smart mobile phones was recently added to the service, allowing fire-fighting authorities to access vital fire information at any time and from any location.

In Nairobi, Kenya, the CSIR installed a new satellite receiver and hosted a training session for Kenyan partners who will be setting up an AFIS service in East Africa.

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KNOWLEDGE DISSEMINATION

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New international patents granted

Patent title	Country	Patent number
A method and apparatus for assessing the integrity of a rock mass	United States	8,515,676
Bioreactor	Brazil	PI 0113876-6
Emulsion-derived particles	Japan	5442624
Imidazopyridines and imidazopyrimidines as HIV-1 reverse transcriptase inhibitors	EPO-European Patent Office	2334675
Imidazopyridines and imidazopyrimidines as HIV-1 reverse transcriptase inhibitors	United States	8,501,767
In-shell pasteurization of eggs	United States	8,569,667
Laser cladding for leaking water vessels	Japan	JP2012512752
Laser cladding for leaking water vessels	Australia	2009329094
Method for converting aloeresin to aloesin	Australia	2006224289
Nanoparticle carriers for drug administration	China	ZL 200880127030.1
Nanoparticle carriers for drug administration	United States	8,518,450
Pharmaceutical compositions having appetite supressant activity	EPO-European Patent Office	1222927
Processing of a molten alloy	Brazil	PI0407363-0
Treatment of erectile dysfunction and libido enhancement	United States	8609151
Treatment of metal-containing water	Australia	2008202077

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 relevant principles incorporated in the Code of Corporate Practices and Conduct, as set out in the King III 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.

Corporate governance

Risk management

The CSIR Board is responsible for ensuring that a comprehensive and effective risk management process is in place.

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 goals and objectives of the CSIR will be attained. This takes cognisance of the fact that the risks identified are often inter-linked, and cannot be managed in isolation. CSIR systems have been put in place to review aspects of economy, efficiency and effectiveness. The management of risk is assigned at appropriate levels to ensure proper responses.

Documented and tested processes are in place which will allow the CSIR to continue its critical business operations, in the event of interruptions impacting on its activities.

Based on the work of internal audit, the organisational results achieved, the audit report on the annual financial statements, and the management report of the Auditor-General, the Board is satisfied that the system of risk management has been effective during the year under review.

The CSIR has defined three broad risk categories, namely: systemic risks, strategic risks and operational risks.

Systemic risks

Systemic risks originate from macro-economic and national challenges affecting the National System of Innovation and National Government Business Enterprise space in which the CSIR operates.

Continued evaluation of macro-economic influences, ongoing assessment and engagement with stakeholders remain key in directing research activities towards achieving the CSIR's mandate.

Strategic risks

The organisation has effective mechanisms in place for identifying and monitoring strategic risks that impact the CSIR Group's ability to deliver on its mandate. The procedures for implementing a risk management process include a focus on areas such as: human capital assessment and development; research impact areas; technological development; and business continuity.

Operational risks

The CSIR endeavours to minimise operating risk by ensuring that the appropriate infrastructure, controls, systems and people are in place throughout the Group. Key processes employed in managing operating risk include research ethics and good research practices; segregation of duties; transaction approval frameworks; financial and management reporting; and monitoring of metrics which are designed to highlight positive or negative performance across the broad range of key results areas (KRAs).
The Operations Committee, which comprises members of the Executive Management Committee, operating unit and centre executive directors, and group managers, oversees operational matters.

Sustainability

The CSIR Board has reviewed the Group's financial budgets for the period 1 April 2014 to 31 March 2017 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 all matters with potential to have material impact on the operations and reputation of the CSIR to itself.

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 PFMA road shows; formal induction programmes; 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 their commitment to a policy of fair dealing and integrity in conducting their operations. The code aligns closely to the CSIR 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 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 27 June 2013, 12 September 2013, 24 October 2013 (strategy session), 14 November 2013 and 20 February 2014. The annual financial statements for the 2013/14 financial year were approved on 26 June 2014.

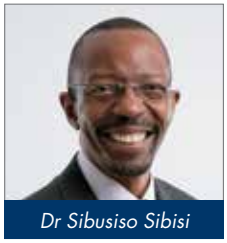
The CSIR Board has the following sub-committees: the Audit and Risk Committee; the Human Resources and Remuneration Committee and the Strategic Review Committee (see pages 114 to 115). These committees are selected according to the skills sets required for the committees to fulfil their functions. For the 2013/14 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 (1 April 2013 to 31 March 2014)

Prof Francis Petersen

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



Dr Sibusiso Sibisi

Chief Executive Officer: CSIR

Prof Mike Wingfield

Director: Forestry and Agricultural Biotechnology Institute, University of Pretoria

Mr McLean Sibanda

Chief Executive Officer: The Innovation Hub Management Company

Mr Phillip Benadè

Retired from the Department of Education. Independent financial consultant

Mr Ghandi Badela

Advocate: Duma Nokwe Group

Prof Eugene Cloete

Dean: Faculty of Science, University of Stellenbosch

Dr Philip Goyns

Supply Option Modelling Specialist: Department of Energy

Ms Malebo Mabitje-Thompson

Chief Operations Officer: Department of Trade and Industry

Prof Tebello Nyokong

Professor: Medicinal Chemistry and Nanotechnology, Rhodes University

Ms Swazi Tshabalala

Chief Executive Officer: Industrial Development Group

The Board and all its committees were appointed on 1 January 2012.

Schedule of attendance of the CSIR Board and CSIR committee meetings (1 April 2013 to 31 March 2014)

Board member	Board meetings	Audit and Risk Committee	Human Resources and Remuneration Committee	Strategic Review Committee
Petersen	5		1*	2
Badela	4	3	2*	1
Benadè	5	4	1*	1*
Cloete	5		1*	2
Goyns	3		3	2*
Mabitje-Thompson	4		2	2*
Nyokong	2			1
Sibanda	5	4	3	1*
Sibisi	5	4[a]	2[a]	2[a]
Tshabalala	5	4		2
Wingfield	3			1

[a] Attends in capacity as CEO
* Attendance by invitation

Members of the Board met with the Executive Authority on 18 April 2013 and 23 September 2013.

Governance structure

Executive Management Committee

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

1. Group Executive, Research and Development: Dr Molefi Motuku
2. Group Executive, Strategic Alliances and Communication: Dr Rachel Chikwamba
3. Chief Financial Officer: Mr Chris Sturdy
4. CEO: Dr Sibusiso Sibisi
5. Group Executive, Shared Services: Mr Raynold Zondo

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

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 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 110 to 111 of the Corporate Governance Report. The membership and Terms of Reference of each Board committee are further described on pages 114 to 115.

Remuneration of Board members and the Executive Management is set out in Note 17 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.

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 (2013/14)

The CSIR Board and its sub-committees were evaluated against accepted good corporate governance principles and practices by the Institute of Directors.

Audit and Risk Committee

April 2013 to March 2014

Chairperson Mr P Benadè

Members Mr M Sibanda
Ms BS Tshabalala
Mr G Badela

Meetings 26 June 2013
11 September 2013
14 November 2013
13 February 2014

Purpose

- To deal with all matters prescribed by the regulations issued in terms of the PFMA and the Scientific Research Council Act;
- 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 2013 to March 2014

Chairperson Mr M Sibanda

Members Dr PH Goyns
Ms MSM Mabitje-Thompson

Meetings 27 June 2013
11 September 2013
13 February 2014

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 2013 to March 2014

Chairperson	Prof FW Petersen
Members	Prof TE Cloete Prof TA Nyokong Prof MJ Wingfield Ms BS Tshabalala Mr G Badela Dr SP Sibisi
Meetings	10 October 2013 13 March 2014

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.

CSIR Board committees (2013/14)

Board and committee meeting attendance (1 April 2013 to 31 March 2014)

Board meetings

Date of meeting	27/06/13	12/09/13	24/10/13	14/11/13	20/02/14
Petersen	Present	Present	Present	Present	Present
Badela	Present	Present	Present	Present	Apology
Benadè	Present	Present	Present	Present	Present
Cloete	Present	Present	Present	Present	Present
Goyns	Present	Present	Apology	Apology	Present
Mabitje-Thompson	Apology	Present	Present	Present	Present
Nyokong	Apology	Apology	Present	Apology	Present
Sibanda	Present	Present	Present	Present	Present
Sibisi	Present	Present	Present	Present	Present
Tshabalala	Present	Present	Present	Present	Present
Wingfield	Present	Apology	Present	Present	Apology

Audit and Risk Committee meetings

Date of meeting	26/06/13	11/09/13	14/11/13	13/02/14
Benadè	Present	Present	Present	Present
Sibanda	Present	Present	Present	Present
Tshabalala	Present	Present	Present	Present
Badela	Present	Present	Present	Apology

Human Resources and Remuneration Committee meetings

Date of meeting	27/06/13	11/09/13	13/02/14
Sibanda	Present	Present	Present
Goyns	Present	Present	Present
Mabitje-Thompson	Apology	Present	Present
Badela	Present*		Present*
Benadè	Apology*		Present*
Petersen	Present*		Apology*
Cloete	Apology*		Present*

* Attendance by invitation

Strategic Review Committee meetings

Date of meeting	10/10/13	13/03/14
Petersen	Present	Present
Sibisi	Present	Present
Wingfield	Present	Apology
Nyokong	Apology	Present
Cloete	Present	Present
Badela	Apology	Present
Tshabalala	Present	Present
Benadè	Apology*	Present*
Sibanda	Apology*	Present*
Mabitje-Thompson	Present*	Present*
Goyns	Present*	Present*

* Attendance by invitation • Meetings are open for all Board members

REPORT OF THE

Audit and Risk Committee

for the year ended 31 March 2014

The committee is pleased to present its report for the financial year ended on 31 March 2014.

The committee's responsibility

The committee has adopted formal Terms of Reference approved by the Board. Accordingly, the committee has conducted its affairs in compliance with its Terms of Reference, and has discharged its responsibilities contained therein.

Independent evaluation of the committee

The Institute of Directors has independently evaluated the performance of the committee against accepted good corporate governance principles and practices.

Committee members and attendance

The committee consists of the members as stated on page 114 of this report. In accordance with its approved Terms of Reference, the committee met quarterly during the year under review (i.e. 26 June 2013, 11 September 2013, 14 November 2013 and 13 February 2014). Schedule of attendance is shown on page 116 of this report.

The effectiveness of internal control

The system of internal control applied by the CSIR over financial risk management is effective, efficient and transparent. In line with the PFMA and King III, the internal audit provides the committee and management with assurance that the internal controls are appropriate and effective. This is achieved by means of the risk management process, as well as the identification of mitigating measures and on-going assessment thereof.

From the various reports of internal audit, the audit report on the annual financial statements, and the management report of the Auditor-General of South Africa, it was noted that no matters were reported that include any material deficiencies in the system of internal control or any deviations therefrom. Accordingly, the committee can report that the system of internal control over financial reporting for the period under review was efficient and effective.

Internal audit

The Group has an internal audit function that has a direct line of reporting to the committee. Its charter and audit plans are approved by the committee to ensure it operates independently.

The committee is satisfied that the internal audit function is operating effectively and has addressed the risks pertinent to the CSIR through its audits.

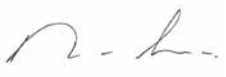
Risk management

The committee is satisfied that the CSIR has a risk management process focused on identifying, assessing, managing and monitoring 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 on 31 March 2014, and based on the information provided, the 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 concurs with the Executive Management that the adoption of the going concern premise in the preparation of the annual financial statements is appropriate. The committee has therefore at its meeting on 25 June 2014, recommended the adoption of the annual financial statements by the CSIR Board.



Phillip Benadè

Chairperson of the Audit and Risk Committee

25 June 2014

REPORT OF THE
Auditor-General for the year ended 31 March 2014

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

Report on the consolidated and separate 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 132 to 171, which comprise the consolidated and separate statement of financial position as at 31 March 2014, the consolidated and separate statement of comprehensive income, statement of changes in equity and the statement of cash flows for the year then ended, as well as the notes, comprising a summary of significant accounting policies and other explanatory information.

Board of directors which constitutes the 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 (SA Statements of GAAP) 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 entity'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 entity'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 2014, and their financial performance and cash flows for the year then ended in accordance with SA Statements of GAAP and the requirements of the PFMA.

Report on other legal and regulatory requirements

In accordance with the PAA and the general notice issued in terms thereof, I report the following findings relevant to performance information against predetermined objectives for selected objectives presented in the annual performance report, non-compliance with legislation as well as internal control. The objective of my test was to identify reportable findings as described under each subheading but not to gather evidence to express assurance on these matters. Accordingly, I do not express an opinion or conclusion on these matters.

Predetermined objectives

I performed procedures to obtain evidence about the usefulness and reliability of the reported performance information for the following selected objectives presented in the annual performance report of the Council for Scientific Industrial Research for the year ended 31 March 2014:

- **Objective 1:** Building and transforming human capital on page 125
- **Objective 2:** Strengthening the SET base and performing relevant R&D on page 125
- **Objective 3:** Transferring knowledge and technology, and implementation to achieve impact on page 126

I evaluated the reported performance information against the overall criteria of usefulness and reliability.

I evaluated the usefulness of the reported performance information to determine whether it was presented in accordance with the National Treasury's annual reporting principles and whether the reported performance was consistent with the planned objectives. I further performed tests to determine whether indicators and targets were well defined, verifiable, specific, measurable, time bound and relevant, as required by the *National Treasury's Framework for managing programme performance information* (FMPPI).

I assessed the reliability of the reported performance information to determine whether it was valid, accurate and complete.

I did not raise any material findings on the usefulness and reliability of the reported performance information for objectives.

Additional matter

I draw attention to the following matter:

– Achievement of planned targets

Refer to the annual performance report on pages 125 to 126; for information on the achievement of planned targets for the year.

Compliance with legislation

I performed procedures to obtain evidence that the entity had complied with applicable legislation regarding financial matters, financial management and other related matters. I did not identify any instances of material non-compliance with specific matters in key legislation,as set out in the general notice issued in terms of the PAA.

Internal control

I considered internal control relevant to my audit of the financial statements, annual performance report and compliance with legislation. I did not identify any significant deficiencies in internal control.

Auditor-General

Pretoria

14 July 2014

AUDITOR-GENERAL SOUTH AFRICA

Auditing to build public confidence

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 2014.

In the opinion of the CSIR Board, the financial statements fairly present the financial position of the CSIR Group as at 31 March 2014 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)

The CSIR defines its role within the mandate as to foster industrial development through technology development and transfer, new industrial sector development, licensing of intellectual property, start-ups, piloting, waste minimisation and strategic initiatives.

A substantial portion of the CSIR's effort is in the transfer of knowledge and technologies to enhance the capabilities of government departments. This includes support to service delivery, policy development and information management. The CSIR balances its contributions to industrial development and enhancing government capabilities so as to contribute optimally to improved quality of life in areas appropriate to its mandate. All contributions are founded on a core of excellent science and engineering.

Income sources

The CSIR is funded through a combination of baseline and ring-fenced grants from the Department of Science and Technology (DST), and earns contract research and development income from the public and private sectors; locally and internationally.

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.

Strategic overview

The CSIR strategy responds to national priorities and is informed by external environmental drivers including:

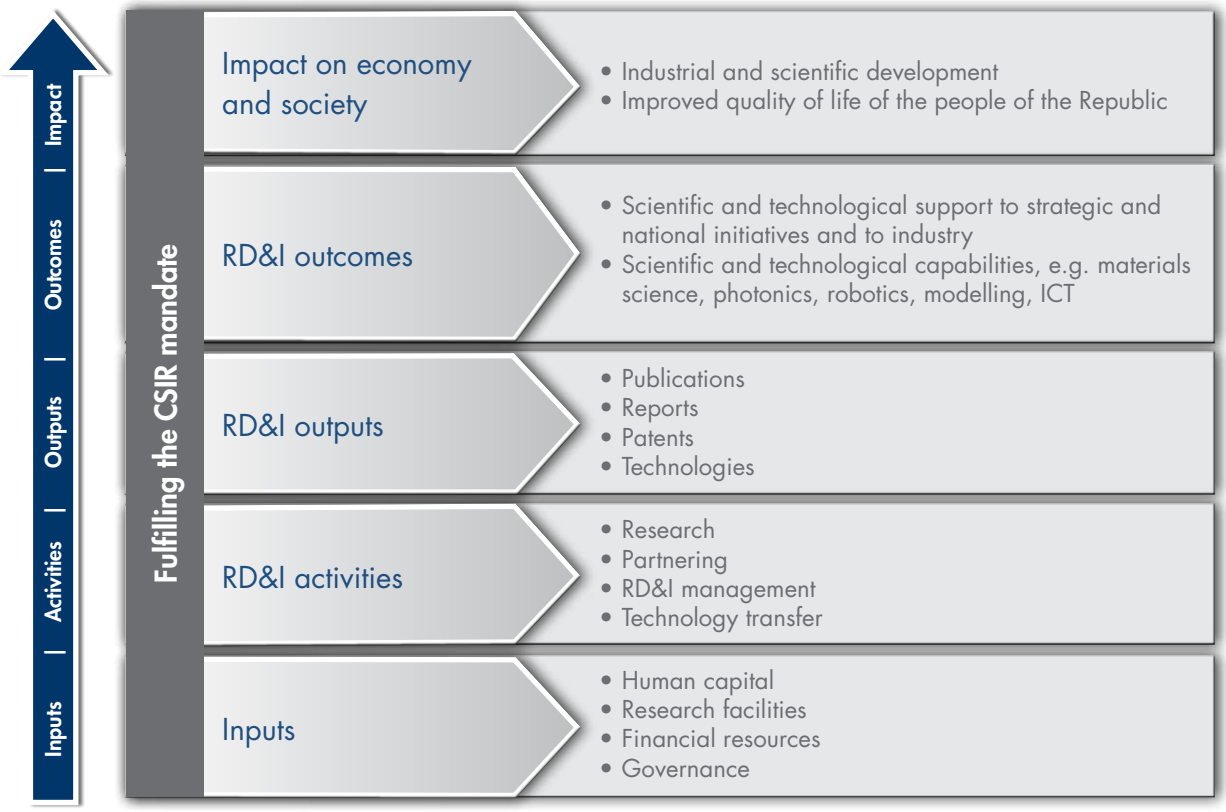
- The Millennium Development Goals, and the 2015 targets that dictate agendas worldwide;
- The New Growth Path approved by Cabinet in 2010;
- The 12 South African national outcomes identified by Cabinet in 2010; and
- The National Development Plan accepted by Cabinet in September 2012.

The response to these drivers builds on the CSIR responses to the DST Ten-Year Innovation Plan and the Department of Trade and Industry Industrial Policy Action Plan.

The CSIR fulfils its mandate through scientific and technological support to strategic national initiatives and to industry in collaboration with national line departments, state-owned enterprises, provincial and local government and the private sector. The CSIR strategy is structured around a framework aligning organisational inputs, activities and outputs with this role and the mandate (Figure 1). The CSIR's role is further defined by organisational competences and capabilities, reinforced through an effective network of local and international research partnerships.

Executive report

Figure 1: *The CSIR role and framework for fulfilling the CSIR mandate*



RD&I: Research, Development and Innovation

CSIR Research, Development and Innovation (RD&I) is guided by Research Impact Area (RIA) strategies. The six CSIR RIAs are: Health; Defence and Security; Built Environment; Natural Environment; Industry; and Energy. The RIAs are supported by core technologies including: Information and Communications Technology, Sensors, Modelling, Photonics, Materials and Robotics, and research facilities.

The RIA strategies continue to mature, informed by stakeholder engagement. The current strategic intent and focus of each RIA is summarised in Table 1, but is subject to ongoing development.

Table 1: *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
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 • Sustainable human settlements • Water infrastructure • Transport infrastructure • Logistics and infrastructure operations
Natural environment		• Assessing and monitoring the state of the natural environment • Support for decision-making and resource planning • Technologies for water, pollution and waste solutions
Industry	Advanced manufacturing	• Titanium industry • Bio-manufacturing industry • Additive manufacturing • Microsystems and micro-manufacturing • Advanced materials and composites for industry
	Mining	• Health and safety • New mining methods • Decision support systems
Energy		• Renewable and alternative energy (under development)

Flagship programmes are being developed that draw on RIA capabilities. The flagships are large, integrated, impact-driven development and innovation initiatives, with clear objectives and intended outcomes that can be achieved within a set time. They are funded initially by the Parliamentary Grant, but partnering with stakeholders to leverage resources and funding is key in pursuing the goals of the programmes.

The CSIR has initiated three flagship programmes:

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

Executive report

Setting of key performance indicators and performance reporting

The CSIR enters into a Shareholder's Compact Agreement with the DST annually. The compact comprises a five-year strategic plan and an operational plan with very specific key performance indicators (KPIs). Setting of KPI targets is supported by ongoing benchmarking against similar research organisations, and trend analysis. 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 several years.

Overview of 2013/14 performance

The CSIR performed very well in attaining the objectives set in its Strategic and Operational Plan. Once again, the organisation has demonstrated high standards of science, financial sustainability and corporate governance. The CSIR has delivered positive financial results, with total operating income continuing to grow, and the net profit for the year exceeding target. Attraction and retention of suitably qualified and capable staff remains an ongoing challenge. However, the CSIR's approach to human capital development and human resource management ensured that all the relevant targets were met or exceeded. Research outputs in terms of publication equivalents did not meet the target, but the number of new technology demonstrators was significantly greater than target.

The target contributor level for Broad-based Black Economic Empowerment (BBBEE) and the excellent safety record were maintained. The target saving in energy consumption was not achieved owing to operational requirements. The CSIR has maintained its record of an unqualified audit report.

Key performance indicators

The CSIR has established a set of enabling processes and conditions that support all RD&I programmes:

- Building and transforming human capital to ensure adequate capacity in the CSIR and contribute to the national skills base;
- Strengthening the science, engineering and technology (SET) base and performing relevant R&D;
- Transferring of knowledge and technology, and implementation to achieve impact in support of national objectives;
- Enhancing financial sustainability; and
- Ensuring good corporate governance and corporate citizenship.

The CSIR's KPIs are presented as follows, grouped according to the enabling processes and conditions.

Building and transforming human capital

Table 2: *Building and transforming human capital*

Strategic focus area	Key performance indicator	2013/14 Target	2013/14 Actual
Human resource management	Total size of SET base (number, %)	1 625 (65.3%)	1 691 (66.5%)
	% of SET base who are black	49.3	51.7
	% of SET base who are female	32.3	32.8
	Number of staff with doctoral level qualifications	310	310

The better than expected growth in SET staff is seen as a very positive indication of growth and was enabled by the sound financial performance. The percentage of total staff that is in the SET base is a measure of organisational efficiency and the result is very positive. The transformation of SET staff continues to improve (Table 2).

The CSIR achieved the target for the number of staff with doctoral degrees. This arises from successful recruitment of suitably qualified staff and ongoing human capital development (HCD). The CSIR supported 86 permanent staff members in attaining their doctoral degrees; 101 in attaining Master's degrees; and 232 studentships (mainly doctoral students) in the course of 2013/14 as part of the organisational HCD efforts.

Strengthening the SET base and performing relevant R&D

The CSIR achieved good performance with regard to its objective of strengthening the SET base, when measured against targets set for its key performance indicators (Table 3).

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

Strategic focus area	Key performance indicator	2013/14 Target	2013/14 Actual
R&D outputs	Publication equivalents	555	477
	New technology demonstrators	28	48
	New patents granted	16	15
	Value of investment in property, plant and equipment	R129.4 m	R134.7 m

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. However, the target for publications was not achieved. The CSIR is increasing efforts in technology transfer and in large integrated programmes to achieve impact in the short term, drawing on the same capacity that publishes, and contributing to fewer publications. Technology demonstrators are a lead indicator of technology transfer and the excellent performance in exceeding this target further illustrates the greater efforts the CSIR is making in this regard. The better than expected performance arises from a sharp increase in technologies submitted by CSIR units for evaluation as technology demonstrators (69 compared to 46 in 2012/13). The number of patents granted during the year was one less than the target. Given the uncertainty in the timing of patent awards, performance is regarded as on target for all practical purposes.

The value of investment in property, plant and equipment exceeded the target, reflecting focused CSIR investment and success in securing additional funding.

Executive report

Transferring knowledge and technology, and implementation

The CSIR R&D capacity provides value to society through the contract R&D it undertakes and through the commercialisation of formally protected intellectual property (Table 4).

Table 4: *Transferring knowledge and technology, and implementation*

Strategic focus area	Key performance indicator	2013/14 Target	2013/14 Actual
R&D outcomes	Royalty and licence income	R5.1 m	R13.7 m
Contract R&D	Contract R&D income[1]	R1 433.3 m	R1 510.6 m
	Private sector and international income[1]	R400.7 m	R364.9 m

[1] This indicator does not include Circular 9 adjustments. The adjusted figures are reflected in note 2 of the annual financial statements.

Royalty and licence income exceeded target owing to increased activity in granting licences to licensees. The CSIR was able to secure better than anticipated contract R&D income and exceeded the annual target. The target for the component earned from the private sector and internationally was not achieved, which is attributed to the prevailing global economic conditions.

Financial sustainability and good corporate governance and citizenship

The CSIR continued to demonstrate its financial sustainability despite the difficult economic climate. Further details are provided in Table 5. The solid performance in achieving corporate governance and citizenship targets was maintained, with the BBBEE contributor level target and the excellent safety record maintained. The target saving in energy consumption on the Pretoria Scientia campus was not achieved, despite energy saving initiatives, owing to growth in CSIR business in recent years.

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

Strategic focus area	Key performance indicator	2013/14 Target	2013/14 Actual
Financial sustainability	Total income	R2.12 billion	R2.15 billion
	Net profit	R43.1 m	R52.3 m
Corporate governance and citizenship	BBBEE rating	Level 2 contributor	Level 2 contributor
	Energy efficiency (% reduction in energy consumption on previous year)	1.2%	0.34%
	Disabling injury frequency rate (DIFR)	<0.3	0.16

Financial performance overview

Income

The total operating income of the CSIR increased by 6.5% to an amount of R2 153.4 million (2012/13: R2 022.8 million). Revenue growth, excluding other income, amounted to 6.5% and 6.2% for the CSIR and CSIR Group respectively.

The Parliamentary Grant recognised as income in 2013/14 amounted to R618.8 million, an increase of 4.1% from the prior year amount of R594.5 million (Figure 2).

The CSIR's total contract R&D income increased by 7.7% to R1 495.8 million (2012/13: R1 389 million). This includes a R65 million (2012/13: R50.3 million) ring-fenced allocation from the DST. The CSIR Group's total contract R&D income increased by 7.7% to an amount of R1 495.6 million (2012/13: R1 388.6 million).

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. Public sector income amounted to R1 134.5 million (2012/13: R1 028 million).

Income from the international sector increased by 11.5% to R203.1 million (2012/13: R182.1 million).

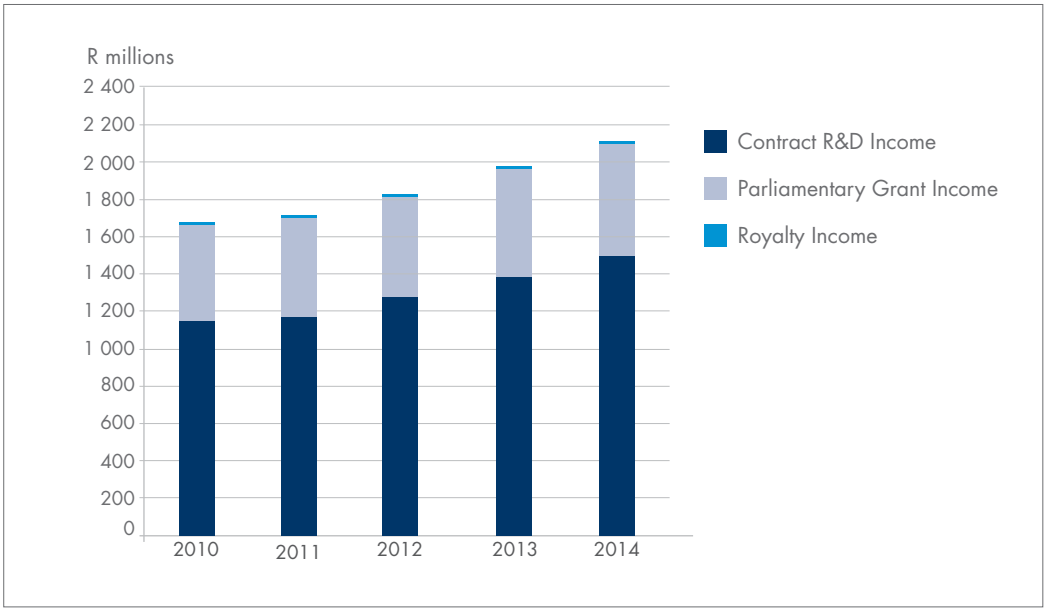


Figure 2: *CSIR income streams for financial years ending 2010–2014*

(The Satellite Application Centre was transferred to the South African National Space Agency on 1 April 2011, resulting in a reduction in international and public sector income in 2011/12)

Investment in property, plant and equipment

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 R746.8 million has been invested in property, plant and equipment with R134.7 million invested in the 2013/14 financial year.

Executive report

Five-year review of income and expense indicators

	2014 R'000	2013 R'000	2012 R'000	2011 R'000	2010 R'000
Total income	**2 202 595**	**2 069 221**	**1 919 381**	**1 776 827**	**1 748 848**
Parliamentary Grant recognised as income	618 849	594 478	556 837	535 357	509 122
Contract income, royalty income, other income and net finance income	**1 583 746**	**1 474 743**	**1 362 544**	**1 241 470**	**1 239 726**
Local private and international sectors	361 353	361 018	320 491	354 389	310 949
Local public sector	1 134 470	1 027 998	952 909	820 705	848 846
Royalties and other income	38 766	39 351	50 771	13 197	11 168
Net finance income	49 157	46 376	38 373	53 179	68 763
Total expenditure	**2 150 262**	**2 020 769**	**1 850 383**	**1 741 317**	**1 695 419**
Employees' remuneration	1 229 566	1 108 202	1 014 879	940 776	873 445
Operating expenses	873 483	867 680	793 680	759 048	779 832
Depreciation	47 213	44 887	41 824	41 493	42 142

Net profit and cash flow

The net profit of the CSIR amounts to R52.3 million (2012/13: R48.5 million). The net profit for the CSIR Group is R54.1 million (2012/13: R53.3 million). Net cash from operating activities for the CSIR amounted to R137.6 million (2012/13: R130.4 million). The cash and cash equivalent holdings of the CSIR increased to R1 043.4 million (2012/13: R983.5 million). The current ratio is comparable to the previous financial year at 1.1.

Five-year ratio analysis

	2014 R'000	2013 R'000	2012 R'000	2011 R'000	2010 R'000
Operating expenses					
Remuneration as a percentage of total income (excluding finance income)	**57.1%**	54.8%	54.0%	54.6%	52.0%
Remuneration as a percentage of total operating expenditure	**57.2%**	54.8%	54.8%	54.0%	51.5%
Asset management					
Investment in property, plant and equipment (Rm)	**134.7**	130.1	184.2	118.8	179.0
Investment in property, plant and equipment as a percentage of revenue	**6.3%**	6.5%	10.0%	6.9%	10.7%
Net asset turn	**3.2**	3.2	3.3	3.3	3.4
Current ratio	**1.1**	1.1	1.1	1.1	1.1
Cash flow					
Net cash from operating activities	**137 626**	130 385	78 562	299 171	25 967
Cash and cash equivalents at end of year (including long-term fixed deposits)	**1 043 427**	**983 511**	949 360	975 755	766 278

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

STATEMENTS OF

Comprehensive income

for the year ended 31 March 2014

	Notes	GROUP 2014 R'000	GROUP 2013 R'000	CSIR 2014 R'000	CSIR 2013 R'000
Revenue	2	**2 128 154**	2 003 315	**2 128 351**	1 998 305
Other income		**25 193**	24 540	**25 087**	24 540
Total operating income		**2 153 347**	2 027 855	**2 153 438**	2 022 845
Expenditure					
Employees' remuneration		**1 231 173**	1 110 208	**1 229 566**	1 108 202
Depreciation and amortisation	6 & 7	**47 240**	44 940	**47 213**	44 887
Operating expenses		**872 017**	866 698	**873 483**	867 680
Total operating expenditure		**2 150 430**	2 021 846	**2 150 262**	2 020 769
Finance income	4	**54 860**	51 965	**53 792**	51 052
Finance expense	4	**(4 635)**	(4 676)	**(4 635)**	(4 676)
Share of profit/(loss) of joint ventures and associates	8	**997**	(34)	**–**	–
Profit before income tax	3	**54 139**	53 264	**52 333**	48 452
Income tax expense	5	**–**	–	**–**	–
Profit for the year		**54 139**	53 264	**52 333**	48 452
Total comprehensive income for the year		**54 139**	53 264	**52 333**	48 452
Profit attributable to:					
Stakeholders of the parent		**54 139**	53 264	**52 333**	48 452
Total comprehensive income attributable to:					
Stakeholders of the parent		**54 139**	53 264	**52 333**	48 452

STATEMENTS OF

Financial position as at 31 March 2014

	Notes	GROUP 2014 R'000	GROUP 2013 R'000	CSIR 2014 R'000	CSIR 2013 R'000
ASSETS					
Non-current assets		**525 085**	488 947	**537 856**	503 877
Property, plant and equipment	6	**515 910**	482 007	**515 880**	481 950
Intangible assets	7	**–**	–	**–**	–
Interest in joint ventures and associates	8	**9 175**	6 940	**1 315**	1 270
Interest in subsidiaries	9	**–**	–	**20 661**	20 657
Current assets		**1 474 858**	1 417 297	**1 452 154**	1 393 521
Trade and other receivables	10	**323 745**	303 192	**323 696**	297 779
Inventory and contracts in progress	11	**85 031**	112 231	**85 031**	112 231
Cash and cash equivalents	22	**1 066 082**	1 001 874	**1 043 427**	983 511
TOTAL ASSETS		**1 999 943**	1 906 244	**1 990 010**	1 897 398
EQUITY AND LIABILITIES					
Reserves		**687 561**	633 422	**678 311**	625 978
Retained earnings		**687 561**	633 422	**678 311**	625 978
Non-current liabilities		**9 772**	10 347	**9 772**	10 347
Post-retirement medical benefits	16.4	**9 772**	10 347	**9 772**	10 347
Current liabilities		**1 302 610**	1 262 475	**1 301 927**	1 261 073
Advances received	13	**778 851**	756 887	**778 851**	756 887
Trade and other payables	14	**523 759**	505 588	**523 076**	504 186
TOTAL EQUITY AND LIABILITIES		**1 999 943**	1 906 244	**1 990 010**	1 897 398

STATEMENTS OF

Changes in equity for the year ended 31 March 2014

	Retained earnings R'000	Total R'000
GROUP		
Balance at 31 March 2012	580 158	**580 158**
Total comprehensive income	53 264	**53 264**
Profit for the year	53 264	**53 264**
Balance at 31 March 2013	**633 422**	**633 422**
Total comprehensive income	54 139	**54 139**
Profit for the year	54 139	**54 139**
Balance at 31 March 2014	**687 561**	**687 561**
CSIR		
Balance at 31 March 2012	577 526	**577 526**
Total comprehensive income	48 452	**48 452**
Profit for the year	48 452	**48 452**
Balance at 31 March 2013	**625 978**	**625 978**
Total comprehensive income	52 333	**52 333**
Profit for the year	52 333	**52 333**
Balance at 31 March 2014	**678 311**	**678 311**

STATEMENTS OF

Cash flows for the year ended 31 March 2014

	Notes	GROUP 2014 R'000	GROUP 2013 R'000	CSIR 2014 R'000	CSIR 2013 R'000
Cash flows from operating activities					
Cash receipts from external customers		**1 528 844**	1 350 354	**1 523 632**	1 350 927
Parliamentary Grant received		**633 678**	601 838	**633 678**	601 838
Cash paid to suppliers and employees		**(2 070 017)**	(1 869 364)	**(2 067 279)**	(1 867 474)
Cash generated from operating activities	21	**92 505**	82 828	**90 031**	85 291
Finance income received	4	**53 298**	50 683	**52 230**	49 770
Finance expense paid	4	**(4 635)**	(4 676)	**(4 635)**	(4 676)
Net cash from operating activities		**141 168**	128 835	**137 626**	130 385
Cash flows from investing activities					
Acquisition of property, plant and equipment	6	**(81 981)**	(99 203)	**(81 981)**	(99 152)
Proceeds on disposal of property, plant and equipment		**4 750**	463	**4 750**	463
Decrease in interest in joint ventures and associates		**750**	500	**–**	–
Acquisition of intangible assets	7	**–**	(271)	**–**	–
Net cash utilised in investing activities		**(76 481)**	(98 511)	**(77 231)**	(98 689)
Cash flows from financing activities					
Net cash utilised in financing activities		**–**	–	**–**	–
Unrealised exchange (losses)/gains on foreign cash balances		**(479)**	2 455	**(479)**	2 455
Net increase in cash and cash equivalents		**64 208**	32 779	**59 916**	34 151
Cash and cash equivalents at beginning of the year		**1 001 874**	969 095	**983 511**	949 360
Cash and cash equivalents at end of the year	22	**1 066 082**	1 001 874	**1 043 427**	983 511

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 2014 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 have been 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.

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

Interest in associates (continued)

The Group's share of the total recognised gains and losses of associates is incorporated in the consolidated financial statements, from the date that significant influence commences until the date that significant influence ceases, using the equity method of accounting. The carrying amount of such interests is reduced to recognise any impairment, other than a temporary impairment, in the value of individual investments.

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).

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

Foreign operations (continued)

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.

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:

- Land: Indefinite
- 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.

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

Research and development (continued)

Development activities involve a plan or design for the production of new or substantially improved products and processes. Development expenditure is capitalised only if development costs can be measured reliably, the product or process is technically and commercially feasible, future economic benefits are probable, and the Group intends to and has sufficient resources to complete development and to use or sell the asset. The expenditure capitalised includes the cost of materials, direct labour and overhead costs that are directly attributable to preparing the asset for its intended use. Other development expenditure is recognised in profit or loss when incurred.

Capitalised development expenditure is measured at cost less accumulated amortisation and accumulated impairment losses.

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.

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

Financial assets (continued)

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.

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.

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.

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.

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

Post-retirement benefits other than pensions (continued)

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 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.

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

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 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 as follows:

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.

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

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.

1 PRINCIPAL ACCOUNTING POLICIES (CONTINUED)

Reporting framework

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 2015.

2 REVENUE

	GROUP				CSIR			
	2014 R'000	**%**	2013 R'000	%	**2014 R'000**	**%**	2013 R'000	%
Parliamentary Grant	**618 849**	**30**	594 478	29	**618 849**	**30**	594 478	29
Parliamentary Grant received	**633 678**	**30**	601 838	30	**633 678**	**30**	601 838	30
Less:								
Grant received for projects started before year-end but not completed	**(71 828)**	**(3)**	(56 999)	(3)	**(71 828)**	**(3)**	(56 999)	(3)
Add:								
Grant received in prior year for projects completed in this year	**56 999**	**3**	49 639	2	**56 999**	**3**	49 639	2
Contract R&D income	**1 495 626**	**69**	1 388 632	70	**1 495 823**	**69**	1 389 016	70
Local private sector	**157 995**	**7**	178 519	9	**158 223**	**7**	178 903	9
Local public sector	**1 134 501**	**52**	1 027 998	52	**1 134 470**	**52**	1 027 998	52
International sector (including Africa)	**203 130**	**10**	182 115	9	**203 130**	**10**	182 115	9
Royalties	**13 679**	**1**	20 205	1	**13 679**	**1**	14 811	1
	2 128 154	**100**	2 003 315	100	**2 128 351**	**100**	1 998 305	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 R14,82 million (2013: R14,12 million) and is included in finance income (note 4).

Included in public sector contract R&D income is R65,04 million (2013: R50,29 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 R33,26 million (2013: R29,38 million).

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

	GROUP		CSIR	
	2014	2013	**2014**	2013
	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	**4 910**	3 495	**4 910**	3 495
Fees for services	**7 433**	10 177	**7 284**	9 945
Patent costs	**6 171**	7 688	**6 022**	7 456
Legal costs	**1 262**	2 489	**1 262**	2 489
Operating leases	**5 844**	8 819	**5 762**	8 755
Buildings	**1 263**	2 681	**1 181**	2 617
Equipment	**3 022**	4 313	**3 022**	4 313
Vehicles	**1 559**	1 825	**1 559**	1 825
Net realised foreign exchange gain	**(28 275)**	(21 741)	**(28 275)**	(21 741)
Net unrealised foreign exchange loss/(gain)	**8 144**	(1 930)	**8 144**	(1 930)
Board members' and Executive Management's emoluments (note 17)	**20 809**	19 720	**18 758**	18 246
Impairments/(reversals of impairments)	**672**	8 062	**2 611**	10 032
(Reversal of impairment)/impairment on subsidiaries, joint ventures and associates	**(1 988)**	(2 102)	**(49)**	107
Impairment on trade receivables	**2 660**	9 925	**2 660**	9 925
Impairment on intangible assets	**–**	239	**–**	–
Bad debt written off	**3 186**	512	**3 186**	512
(Profit)/loss on disposal and write-off of property, plant and equipment	**(3 912)**	785	**(3 912)**	776
Lost and/or stolen equipment and vehicles*	**655**	958	**655**	958
Losses incurred	**1 283**	2 464	**1 283**	2 464
Losses recovered	**(628)**	(1 506)	**(628)**	(1 506)

* 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	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000
4 FINANCE INCOME/EXPENSE				
Finance income	**54 860**	51 965	**53 792**	51 052
Interest on bank balances and investments	**40 042**	37 850	**38 974**	36 937
Adjustment on initial recognition of contract R&D income*	**14 818**	14 115	**14 818**	14 115
Finance expense	**(4 635)**	(4 676)	**(4 635)**	(4 676)
Adjustment on initial recognition of operating expenses*	**(4 635)**	(4 676)	**(4 635)**	(4 676)
	50 225	47 289	**49 157**	46 376

* 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.

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 rate of taxation	**28%**	28%
Profit attributable to tax-exempt entities	**(27%)**	(26%)
Assessed loss (refer note 12)	**1%**	(1%)
Share of profit of associate	**(2%)**	(1%)
Current and deferred taxation – effective rate	**0%**	0%

6 PROPERTY, PLANT AND EQUIPMENT

	2014			2013		
	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**	4 821	–	4 821
Buildings	**407 078**	**68 262**	**338 816**	383 249	68 059	315 190
Equipment	**602 573**	**432 180**	**170 393**	566 269	406 553	159 716
Vehicles	**6 823**	**4 943**	**1 880**	6 848	4 568	2 280
	1 021 295	**505 385**	**515 910**	961 187	479 180	482 007
CSIR						
Land	**4 821**	**–**	**4 821**	4 821	–	4 821
Buildings	**407 078**	**68 262**	**338 816**	383 249	68 059	315 190
Equipment	**602 479**	**432 116**	**170 363**	566 161	406 502	159 659
Vehicles	**6 823**	**4 943**	**1 880**	6 848	4 568	2 280
	1 021 201	**505 321**	**515 880**	961 079	479 129	481 950

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 2012	4 821	265 196	156 266	2 677	**428 960**
Additions	–	50 196	48 919	88	**99 203**
Disposals and write-offs	–	–	(1 222)	(26)	**(1 248)**
Depreciation	–	(202)	(44 247)	(459)	**(44 908)**
Carrying value 31 March 2013	4 821	315 190	159 716	2 280	**482 007**
Additions	–	23 828	58 060	93	**81 981**
Disposals and write-offs	–	–	(838)	–	**(838)**
Depreciation	–	(202)	(46 545)	(493)	**(47 240)**
Carrying value 31 March 2014	**4 821**	**338 816**	**170 393**	**1 880**	**515 910**
CSIR					
Carrying value 31 March 2012	4 821	265 196	156 230	2 677	**428 924**
Additions	–	50 196	48 868	88	**99 152**
Disposals and write-offs	–	–	(1 213)	(26)	**(1 239)**
Depreciation	–	(202)	(44 226)	(459)	**(44 887)**
Carrying value 31 March 2013	4 821	315 190	159 659	2 280	**481 950**
Additions	–	23 828	58 060	93	**81 981**
Disposals and write-offs	–	–	(838)	–	**(838)**
Depreciation	–	(202)	(46 518)	(493)	**(47 213)**
Carrying value 31 March 2014	**4 821**	**338 816**	**170 363**	**1 880**	**515 880**

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 R2,5 million (2013: R2,1 million) decrease in the depreciation amount for the current financial year.

Included above are assets with a cost of R155,6 million (2013: R153,4 million) that are fully depreciated as the remaining useful life is incidental.

During the current financial year, assets to the value of R52,7 million (2013: R30,9 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 R393,2 million (2013: R346,5 million).

7 INTANGIBLE ASSETS

	2014			2013		
	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	**10 739**	**10 739**	**–**	10 739	10 739	–

	GROUP
	R'000
Carrying value 31 March 2012	–
Additions	271
Impairment*	(239)
Amortisation	(32)
Carrying value 31 March 2013	–
Carrying value 31 March 2014	**–**

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

	GROUP		CSIR	
	2014	2013	**2014**	2013
	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	**36 187**	36 937	**33 937**	33 937
Share of post-acquisition losses	**(18 286)**	(19 283)	**–**	–
Share of pre-acquisition gains	**151**	151	**–**	–
	18 053	17 806	**33 938**	33 938
Impairment of joint ventures and associates	**(8 878)**	(10 866)	**(32 623)**	(32 668)
	9 175	6 940	**1 315**	1 270

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 2014 are as follows:

Name of joint venture/associate	Place of incorporation	Portion of ownership interest	Portion of voting power held	Principal activity	Carrying value 2014 R'000	Carrying value 2013 R'000	Financial year-end
Joint ventures							
Sera (Pty) Ltd	South Africa	50%	50%	Commercialisation and licensing of patents	**8 878**	10 866	31 March
Ellipsoid Technology (Pty) Ltd	South Africa	50%	50%	Development of encapsulation technology	**1 325**	1 280	31 March
Associates							
Uvirco Technologies (Pty) Ltd	South Africa	45%	45%	Manufacturing of high technology cameras	**7 850**	5 660	31 March
					18 053	17 806	

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	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000
Current assets	**19 660**	22 177	**21 922**	17 704
Non-current assets	**33 056**	30 091	**3 450**	3 235
Current liabilities	**53 610**	49 953	**11 475**	12 577
Non-current liabilities	**48 232**	48 232	**1 250**	2 250
Income	**1 132**	1 727	**37 690**	32 964
Expenses	**5 019**	6 714	**31 156**	28 264

9 INTEREST IN SUBSIDIARIES

	CSIR	
	2014	2013
	R'000	R'000
Shares at cost less impairment losses	**4 650**	4 650
Indebtedness	**16 011**	16 007
– by subsidiaries	**32 500**	32 500
– impairment of loans	**(16 489)**	(16 493)
	20 661	20 657

Details disclosed in Addendum A.

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

Agreements have been entered into between the CSIR and certain subsidiaries to subordinate the loans made to those subsidiaries. The subordination agreements will remain in force for as long as the liabilities of the relevant subsidiaries exceed their assets, fairly valued.

	GROUP		CSIR	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000

10 TRADE AND OTHER RECEIVABLES

Trade receivables	**288 754**	282 943	**288 728**	278 518
Prepaid expenditure	**25 696**	19 035	**25 696**	19 035
Other receivables	**9 295**	1 214	**9 272**	226
	323 745	303 192	**323 696**	297 779

Trade receivables are shown net of impairment losses. Refer to note 20 for more detail on trade receivables.

11 INVENTORY AND CONTRACTS IN PROGRESS

Contracts in progress less provision for losses	**83 655**	111 351	**83 655**	111 351
Raw materials and consumables	**1 376**	880	**1 376**	880
	85 031	112 231	**85 031**	112 231

Estimates on contract in progress recognition are based on cost to completion, budgets and percentage of completion.

12 DEFERRED TAX

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	**5 004**	7 604
Assessed tax loss generated/(utilised) for the year	**1 127**	(2 600)
Assessed tax loss carried forward	**6 131**	5 004

	GROUP		CSIR	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000
13 ADVANCES RECEIVED				
Advances on contracts received from clients and stakeholders	**778 851**	756 887	**778 851**	756 887
14 TRADE AND OTHER PAYABLES				
Accounts payable and accruals	**371 680**	351 547	**370 997**	350 145
Salary-related accruals	**152 079**	154 041	**152 079**	154 041
	523 759	505 588	**523 076**	504 186

15 OPERATING LEASE COMMITMENTS

Financial commitments under non-cancellable operating leases will result in the following payments falling due:

Within one year:	**1 391**	1 176	**1 312**	1 114
Land and buildings	**199**	182	**120**	120
Vehicles	**1 192**	994	**1 192**	994
Within two to five years:	**1 379**	1 316	**1 379**	1 316
Land and buildings	**–**	120	**–**	120
Vehicles	**1 379**	1 196	**1 379**	1 196

Agreements relating to operating lease payments for vehicles vary from 12 to 48 months and payments are fixed for the term of the agreements.

The CSIR leases buildings under operating leases. The lease periods vary from 12 to 60 months. Lease payments are increased with a fixed annual escalation percentage to reflect market rentals. None of the leases include contingent rentals.

16 RETIREMENT BENEFITS OF EMPLOYEES

16.1 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 R82,7 million (2013: R74,0 million) and employee contributions of R48,3 million (2013: R43,4 million) were expensed during the year.

16.2 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 one employee (2013: two employees) who had formally converted their secondment to a CSIR appointment, employer contributions of R1 512 (2013: R105 611) and employee contributions of R936 (2013: R58 342) were expensed during the year. Employer contributions are charged against income when incurred.

16.3 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 (2013: one employee) who is a member of the AIPF as at 31 March 2014. The fund is controlled by the state, which has assumed responsibility for the unfunded portions of these funds.

Employer contributions of R5 951 (2013: R5 587) and employee contributions of R3 719 (2013: R3 492) were expensed during the year.

16.4 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 (2013: 18 continuation members) was recalculated by the actuaries as at 31 March 2014 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	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000

16 RETIREMENT BENEFITS OF EMPLOYEES (CONTINUED)

16.4 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	**9 772**	10 347	**9 772**	10 347
Net liability on statement of financial position	**9 772**	10 347	**9 772**	10 347

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

Interest cost	**827**	702	**827**	702
Actuarial (gain)/loss recognised during the year	**(1 402)**	1 385	**(1 402)**	1 385
	(575)	2 087	**(575)**	2 087

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

Net liability at the beginning of the year	**10 347**	8 260	**10 347**	8 260
Movement for the year	**(575)**	2 087	**(575)**	2 087
Net (income)/expense recognised in the statement of comprehensive income	**(575)**	2 087	**(575)**	2 087
Net liability at the end of the year	**9 772**	10 347	**9 772**	10 347

	GROUP		CSIR	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000

16 RETIREMENT BENEFITS OF EMPLOYEES (CONTINUED)

16.4 Post-retirement medical benefits (continued)

Principal actuarial assumptions at the reporting date:

Discount rate at 31 March	**8.70%**	8.00%	**8.70%**	8.00%
Medical inflation costs	**6.40%**	6.40%	**6.40%**	6.40%

The aforementioned 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	**655**	782	**655**	782

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	**(593)**	(702)	**(593)**	(702)

Historical information	**2014**	2013	2012	2011	2010
Present value of the defined benefit obligation	**9 772**	10 347	8 260	10 142	9 875
Deficit in the plan	**9 772**	10 347	8 260	10 142	9 875

17 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION

2014

	Entity	Fees for services as director	Managerial Services				Total
			Basic salary	Bonuses and performance-related payments	Retirement fund and medical aid contributions	Sale of accrued leave*	
		R'000	R'000	R'000	R'000	R'000	R'000
Board members and Executive Directors							
Dr SP Sibisi	CSIR	–	3 330	1 622	558	1 236	**6 746**
Non-executive Board members							
Mr G Badela	CSIR	110	–	–	–	–	**110**
Mr P Benadè	CSIR	123	–	–	–	–	**123**
Professor TE Cloete	CSIR	92	–	–	–	–	**92**
Dr PH Goyns	CSIR	–	–	–	–	–	**–**
Ms MSM Mabitje-Thompson	CSIR	–	–	–	–	–	**–**
Professor TA Nyokong	CSIR	37	–	–	–	–	**37**
Professor FW Petersen	CSIR	120	–	–	–	–	**120**
Mr M Sibanda	CSIR	138	–	–	–	–	**138**
Ms BS Tshabalala	CSIR	110	–	–	–	–	**110**
Professor MJ Wingfield	CSIR	46	–	–	–	–	**46**
Executive Management							
Dr RK Chikwamba	CSIR	–	1 684	571	123	87	**2 465**
Dr M Motuku	CSIR	–	2 028	579	176	42	**2 825**
Mr CR Sturdy	CSIR	–	1 944	803	345	–	**3 092**
Mr RM Zondo	CSIR	–	1 925	736	193	–	**2 854**
Subsidiaries							
Non-executive Board member							
Mr M Sibanda	Technifin (Pty) Ltd	56	–	–	–	–	**56**
Executive Management							
Mr JG Hattingh	Technifin (Pty) Ltd	–	1 546	449	–	–	**1 995**
2014		**832**	**12 457**	**4 760**	**1 395**	**1 365**	**20 809**

17 BOARD MEMBERS, DIRECTORS AND EXECUTIVE MANAGEMENT'S REMUNERATION (CONTINUED)

2013

	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	Managerial Services: Sale of accrued leave*	Total
		R'000	R'000	R'000	R'000	R'000	R'000
Board members and Executive Directors							
Dr SP Sibisi	CSIR	–	3 111	1 670	517	–	**5 298**
Non-executive Board members							
Mr G Badela	CSIR	113	–	–	–	–	**113**
Mr P Benadè	CSIR	133	–	–	–	–	**133**
Professor TE Cloete	CSIR	70	–	–	–	–	**70**
Dr PH Goyns	CSIR	–	–	–	–	–	**–**
Ms MSM Mabitje-Thompson	CSIR	–	–	–	–	–	**–**
Professor TA Nyokong	CSIR	52	–	–	–	–	**52**
Professor FW Petersen	CSIR	102	–	–	–	–	**102**
Mr M Sibanda	CSIR	99	–	–	–	–	**99**
Ms BS Tshabalala	CSIR	104	–	–	–	–	**104**
Professor MJ Wingfield	CSIR	43	–	–	–	–	**43**
Executive Management							
Dr RK Chikwamba	CSIR	–	1 700	210	119	–	**2 029**
Dr JH Maree (until March 2013)	CSIR	–	1 944	848	258	–	**3 050**
Dr M Motuku (from June 2012)	CSIR	–	1 604	–	138	–	**1 742**
Mr CR Sturdy	CSIR	–	1 751	827	327	–	**2 905**
Mr RM Zondo	CSIR	–	1 735	597	174	–	**2 506**
Subsidiaries							
Non-executive Board member							
Mr M Sibanda	Technifin (Pty) Ltd	23	–	–	–	–	**23**
Executive Management							
Mr JG Hattingh	Technifin (Pty) Ltd	–	1 451	–	–	–	**1 451**
2013		**739**	**13 296**	**4 152**	**1 533**	**–**	**19 720**

* The approved changes to the CSIR conditions of service, effective 1 April 2013, resulted in amendments to leave days and the accumulation of leave. Leave accrued as at 1 April 2013 has to be utilised or sold within two years.

	GROUP		CSIR	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000
18 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.

19 CAPITAL COMMITMENTS				
Property, plant and equipment	**82 036**	44 666	**82 036**	44 666

This capital expenditure is to be financed from internal sources.

20 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.

20 FINANCIAL INSTRUMENTS (CONTINUED)

20.1 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 2014					
	Total R'000	**ZAR R'000**	**EURO R'000**	**USD R'000**	**GBP R'000**	**Other R'000**
Trade receivables	**288 754**	262 806	1 139	23 120	689	1 000
Bank accounts	**149 743**	77 469	2 324	64 572	4 451	927
Trade and other payables	**(523 759)**	(470 425)	(50 340)	(2 994)	–	–
Gross statement of financial position exposure	**(85 262)**	(130 150)	(46 877)	84 698	5 140	1 927
Forward exchange contracts	**(5 478)**	–	(5 478)	–	–	–
Net exposure	**(90 740)**	**(130 150)**	**(52 355)**	**84 698**	**5 140**	**1 927**

	31 MARCH 2013					
	Total R'000	**ZAR R'000**	**EURO R'000**	**USD R'000**	**GBP R'000**	**Other R'000**
Trade receivables	**282 943**	249 767	948	30 481	1 060	687
Bank accounts	**179 925**	133 782	8 661	36 604	757	121
Trade and other payables	**(505 588)**	(501 442)	(1 648)	(1 439)	(788)	(271)
Gross statement of financial position exposure	**(42 720)**	(117 893)	7 961	65 646	1 029	537
Forward exchange contracts	**–**	–	–	–	–	–
Net exposure	**(42 720)**	**(117 893)**	**7 961**	**65 646**	**1 029**	**537**

	GROUP	
	2014	2013

20 FINANCIAL INSTRUMENTS (CONTINUED)

20.1 Market risk (continued)

Foreign currency risk (continued)

The following significant exchange rates applied during the year:

	R	R
Average rate of forward exchange contracts: Euro	**14.7727**	–
Year-end spot rate:		
Euro	**14.5514**	11.8346
USD	**10.5761**	9.2351
GBP	**17.5980**	14.0368

Sensitivity analysis

A 10% strengthening of the rand against the following currencies at 31 March would have increased/(decreased) profit or loss by the amounts shown below. This analysis assumes that all other variables remain constant. The analysis is performed on the same basis for 2013.

	R'000	R'000
Euro	**5 236**	(796)
USD	**(8 470)**	(6 565)
GBP	**(514)**	(103)
Other	**(193)**	(54)

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	**860 713**	772 808

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	
	2014	2013
	R'000	R'000

20 FINANCIAL INSTRUMENTS (CONTINUED)

20.1 Market risk (continued)

Interest rate risk (continued)

Variable rate instruments: carrying amount

Financial assets: Call deposits	**55 000**	49 000
Financial assets: Bank balances	**149 743**	179 925
	204 743	228 925

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 2013.

Variable rate instruments	**2 047**	2 289

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

20.2 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 18 for details on bank guarantees issued with respect to facilities.

20 FINANCIAL INSTRUMENTS (CONTINUED)

20.2 Credit risk (continued)

	GROUP	
	2014	2013
	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*	**860 713**	772 808
Other cash and cash equivalents:		
– *Call deposits*	**55 000**	49 000
– *Bank balances*	**149 743**	179 925
– *Cash on hand and cash deposits*	**626**	141
Loans and receivables:		
– *Trade and other receivables*	**323 745**	303 192
– *Contracts in progress less provision for losses*	**83 655**	111 351
	1 473 482	1 416 417

The maximum exposure to credit risk for trade receivables at the reporting date by type of customer was:		
Local public	**223 494**	197 496
Local private	**38 625**	50 479
International	**26 635**	34 968
	288 754	282 943

The Group's most significant customers are government institutions.

The aging of the Group's trade receivables at the reporting date was:

	2014		2013	
	Gross	**Impairment**	Gross	Impairment
	R'000	**R'000**	R'000	R'000
Not past due	**228 040**	**210**	244 019	1 987
Past due 0 – 30 days	**29 550**	**95**	28 536	323
Past due 31 – 120 days	**31 634**	**2 944**	12 547	3 888
Past due more than 120 days	**19 349**	**16 570**	15 000	10 961
	308 573	**19 819**	300 102	17 159

20 FINANCIAL INSTRUMENTS (CONTINUED)

20.2 Credit risk (continued)

Exposure to credit risk (continued)

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

	GROUP	
	2014	2013
	R'000	R'000
Balance at 1 April	**17 159**	7 234
Impairment	**2 660**	9 925
Balance at 31 March	**19 819**	17 159

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 R6,2 million (2013: R2,2 million), utilisation of R6,0 million (2013: R2,1 million) and new impairment allowances of R14,9 million (2013: R14,2 million).

20.3 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 (2013: R500 000) available.

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

	2014			2013		
	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	**(523 759)**	**(523 759)**	**–**	(505 588)	(505 588)	–
Derivative financial liabilities						
Forward exchange contracts	**(152)**	**(5 582)**	**–**	–	–	–
	(523 911)	**(529 341)**	**–**	(505 588)	(505 588)	–

20 FINANCIAL INSTRUMENTS (CONTINUED)

20.3 Liquidity risk (continued)

	2014 R	2013 R
Rate of forward exchange contracts:		
Euro	15.0550	–

20.4 Fair values

At 31 March 2014 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.

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).

	Level 1	Level 2	Level 3	Total
31 March 2014				
Forward exchange contracts	–	(152)	–	(152)
31 March 2013				
Forward exchange contracts	–	–	–	–

	GROUP		CSIR	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000

21 RECONCILIATION OF OPERATING PROFIT TO CASH GENERATED FROM OPERATING ACTIVITIES

Operating profit for the year before taxation	**54 139**	53 264	**52 333**	48 452
Adjusted for:				
Depreciation and amortisation	**47 240**	44 940	**47 213**	44 887
Net unrealised foreign exchange loss/(gain)	**8 144**	(1 930)	**8 144**	(1 930)
Net finance income	**(50 225)**	(47 289)	**(49 157)**	(46 376)
Post-retirement medical benefits	**(575)**	2 087	**(575)**	2 087
Straight-lining adjustment of operating leases	**5**	(130)	**5**	(130)
Leave accrual and warranty provision	**16 140**	7 330	**16 140**	7 330
Impairments	**672**	8 062	**2 611**	10 032
(Profit)/loss on disposal and write-off of property, plant and equipment	**(3 912)**	785	**(3 912)**	776
Share of (profit)/loss of joint ventures and associates	**(997)**	34	**–**	–
Bad debt written off	**3 186**	512	**3 186**	512
Operating profit before changes in working capital	**73 817**	67 665	**75 988**	65 640
Increase in trade and other receivables	**(25 096)**	(132 514)	**(30 460)**	(127 301)
Decrease/(increase) in inventory and contracts in progress	**19 937**	(45 838)	**19 937**	(45 838)
Increase in advances received	**21 964**	138 267	**21 964**	138 267
Increase in trade and other payables and provisions	**1 883**	55 248	**2 602**	54 523
Net working capital changes	**18 688**	15 163	**14 043**	19 651
Cash generated from operating activities	**92 505**	82 828	**90 031**	85 291

	GROUP		CSIR	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000

22 CASH AND CASH EQUIVALENTS

Fixed deposits	**860 713**	772 808	**842 000**	757 502
Call deposits	**55 000**	49 000	**53 000**	47 000
Bank balances	**149 743**	179 925	**147 801**	178 868
Cash on hand and cash deposits	**626**	141	**626**	141
	1 066 082	1 001 874	**1 043 427**	983 511

23 RELATED PARTY TRANSACTIONS

The CSIR is a schedule 3B National Government Business Enterprise 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 and 3.

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.

23.1 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	**682**	–	**682**	–
Services received	**–**	38	**–**	38
Amount due from/(to)	**323**	(23)	**323**	(23)
Major public entities				
Services rendered	**309 629**	301 547	**309 629**	301 547
Services received	**291 348**	91 299	**291 348**	91 299
Amount due from	**46 333**	23 148	**46 333**	23 148
National public entities				
Services rendered	**94 629**	83 901	**94 629**	83 901
Services received	**16 468**	10 549	**16 468**	10 549
Amount due from	**8 484**	11 619	**8 484**	11 619

	GROUP		CSIR	
	2014	2013	**2014**	2013
	R'000	R'000	**R'000**	R'000

23 RELATED PARTY TRANSACTIONS (CONTINUED)

23.1 Transactions with related parties (continued)

National government business enterprises				
Services rendered	**4 690**	3 075	**4 690**	3 075
Services received	**4 161**	792	**4 161**	792
Amount due (to)/from	**(2 739)**	719	**(2 739)**	719
Provincial public entities				
Services rendered	**25**	300	**25**	300
Provincial government business enterprises				
Services rendered	**10 240**	3 038	**10 240**	3 038
Amount due from	**1 366**	6 094	**1 366**	6 094
Government departments				
Services rendered	**1 239 420**	1 211 034	**1 239 420**	1 211 034
Services received	**10 799**	881	**10 799**	881
Amount due from	**155 145**	162 276	**155 145**	162 276
Subsidiaries				
Services rendered	**–**	–	**533**	7 155
Services received	**–**	–	**53**	–
Amount due from	**–**	–	**5**	7 397
Joint ventures and associates				
Services rendered	**2 426**	425	**2 117**	155
Services received	**34**	300	**34**	211
Amount due to	**(16)**	(3)	**(16)**	(32)

23.2 Transactions with key management

Total remuneration of key management is included in employees' remuneration (refer to note 17 for Executive Management's remuneration).

ADDENDUM A:

Interest in subsidiaries 31 March 2014

Consolidated subsidiaries	Country of incorporation	Issued capital	Effective holding		Financial year-end	Interests of the CSIR: Shares at cost less accumulated impairment losses	
			2014	2013		2014	2013
		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	**–**	–
						4 650	4 650

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 2014

Interests of the CSIR				
Net indebtedness less accumulated impairment losses by subsidiaries		Net investment		General nature of business
2014 R'000	2013 R'000	**2014 R'000**	2013 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.
4 011	4 007	**4 011**	4 007	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.
16 011	16 007	**20 661**	20 657	

Abbreviations

3G	Third Generation Technology Network
AFCAP	Africa Community Access Programme
AFIS	Advanced Fire Information System
Aids	Acquired immunodeficiency syndrome
AIPF	Associated Institutions Pension Fund
BB4All	Broadband for All
BBBEE	Broad-based Black Economic Empowerment
BIDC	Biomanufacturing Industry Development Centre
CEO	Chief Executive Officer
CHPC	Centre for High Performance Computing
CO_2	Carbon dioxide
COMRO	Chamber of Mines Research Organisation
COP17	17th Conference of the Parties to the United Nations Framework Convention on Climate Change
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs
DIFR	Disabling Injury Frequency Rate
DNA	Deoxyribonucleic acid
DST	Department of Science and Technology
EPO	European Patent Office
FCTR	Foreign currency translation reserve
FMPPI	Framework for managing programme performance information
GAAP	Generally Accepted Accounting Practice
GBP	Great British Pound
GDP	Gross Domestic Product
GPS	Global Positioning System
GRAP	Generally Recognised Accounting Practice
GWh	Gigawatt hour
HCD	Human Capital Development
HIV	Human Immunodeficiency Virus
HVS	Heavy vehicle simulator
IAS	International Accounting Standard
IBT	Innovative building technology
ICT	Information and Communication Technology
IEE	Industrial Energy Efficiency
IFRS	International Financial Reporting Standards
KRA	Key results area
MRC	Medical Research Council
NCPC-SA	National Cleaner Production Centre of South Africa
NDP	National Development Plan
NSI	National System of Innovation
PAA	Public Audit Act
PBN	a-phenyl-N-tert-butylnitrone
PFMA	Public Finance Management Act
R&D	Research and Development
RDI (also RD&I)	Research, Development and Innovation
RIA	Research Impact Area
RNA	Ribonucleic acid
SA	South Africa
SADC	Southern African Development Community
SAICA	South African Institute of Chartered Accountants
SANParks	South African National Parks
SANRAL	South African National Roads Agency Limited
SANReN	South African National Research Network
SAPS	South African Police Service
SARDM	South African Road Design Method
SET	Science, engineering and technology
SKA	Square Kilometre Array
SMME	Small, Medium and Micro Enterprise
TB	Tuberculosis
the dti	Department of Trade and Industry
TV	Television
UAS	Unmanned Aircraft Systems
UHF	Ultra-high frequency
UK	United Kingdom
USA (also US)	United States of America
USD	United States Dollar
VHF	Very-high frequency
WHO	World Health Organization
WIO	Western Indian Ocean
WWF	World Wide Fund for Nature

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