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Science and Technology

South Africa's science and technology sector is filled with examples of competence and excellence. The country has a respected and world-class science and technology community that, over many decades, has pioneered globally significant and successful new ideas, techniques and technologies.

These include the complex techniques to produce fuels and useful chemicals from raw coal, pioneering steel production, the extreme engineering and chemistry required to extract minerals from the deepest mines in the world, medical expertise that not only saw the country pioneering the world's first heart transplant, but makes South Africa-trained doctors in demand – and working – all over the world. In recent years, South Africa has developed a thriving space science industry and by 2020, the country is expected to be playing a leading role in the world of astronomy.

In 2012, the Square Kilometre Array (SKA) Organisation announced that South Africa and Australia would share the hosting of the most advanced scientific project in the world, thus firmly cementing South Africa's position as a major player on the world's science and technology stage. Once completed, the SKA will be the world's biggest telescope.

According to the SKA Organisation, the two biggest components – about 70% of the facility – will be built in Africa, while one will be built in Australia. Among the many benefits for South Africa, the SKA is set to attract scientists and engineers from around the world to our shores; many leading researchers have already joined up to use our facilities. The SKA, which will be one of the biggest single global science projects the world has ever seen, will also contribute towards skills development, job creation, and economic growth.

The MeerKAT Array is currently taking shape in the Karoo and will be the largest and most sensitive radio telescope in the Southern Hemisphere until the SKA is completed around 2024.

As the government body responsible for the science and technology sector, the Department of Science and Technology is tasked with developing, coordinating and managing the National

System of Innovation (NSI) that will bring about maximum human capital, sustainable economic growth and improved quality of life.

In this context the department is tasked with ensuring greater coordination and integration, as well as better management of all government-funded science and technology institutions, and to provide a holistic overview of public expenditure on science and technology.

The department funds basic research at universities and public entities, including science councils, so that they can train scientists, engineers and technologists and produce publications and patents.

Almost 60% of the department's R4,4 billion budget is spent on public entities. Of the overall research and development spend, the greatest portion is on the natural, medical and health sciences.

Legislation

The Department of Science and Technology is governed by the following legislation, among others:

- Intellectual Property Rights from Publicly Financed Research and Development (IPR) Act, 2008 (Act 51 of 2008): This Act provides for the more effective use of intellectual property emanating from publicly financed research and development, through the establishment of the National Intellectual Property Management Office (Nipmo), the Intellectual Property Fund, and offices of technology transfer at institutions.
- Technology Innovation Act, 2008 (Act 26 of 2008): Intended to promote the development and exploitation, in the public interest, of discoveries, inventions, innovations and improvements, and for that purpose establishes the Technology Innovation Agency (TIA).
- South African National Space Agency (Sansa) Act, 2008 (Act 36 of 2008): This Act establishes the Sansa to promote space science research, cooperation in space-related activities, and the creation of an environment conducive to the development of space technologies by industry.
- Natural Scientific Professions Act, 2003 (Act 27 of 2003): This Act establishes the South African Council for Natural Scientific Professions, and legislates the registration of professional natural scientists, natural scientists-in-training, natural science technologists and natural science technologists-in-training.
- National Research Foundation (NRF) Act, 1998 (Act 23 of 1998): Establishes the NRF to promote basic and applied research, as well as the extension and transfer of knowledge in the various fields of science and technology.
- National Advisory Council on Innovation (Naci) Act, 1997 (Act 55 of 1997): Establishes the Naci to advise the Minister of Science and Technology on the role and contribution of science, mathematics, innovation and technology in promoting and achieving national objectives.
- Africa Institute of South Africa (Aisa) Act, 2001 (Act 68 of 2001): Establishes the Aisa to promote knowledge and understanding of African affairs by encouraging leading social scientists to act in concert and across all disciplines, and by collecting and disseminating information on African affairs.
- Human Sciences Research Council (HSRC) Act, 2008 (Act 17 of 2008): Provides for the continued existence of the HSRC, which carries out research that generates critical and independent knowledge relative to all aspects of human and social development.
- The Scientific Research Council Act, 1988 (Act 46 of 1988): Refers to the activities of the Council for Scientific and Industrial Research (CSIR), one of the leading scientific and technological research, development and implementation organisations in Africa, which undertakes directed research and development for socio-economic growth in areas including the built environment, defence, the environmental sciences, and biological, chemical and laser technologies.
- Astronomy Geographic Advantage Act, 2007 (Act 21 of 2007): Provides for the preservation and protection of areas in South Africa

that are uniquely suited to optical and radio astronomy, and for intergovernmental cooperation and public consultation on matters concerning nationally significant astronomy advantage areas.

The Department of Science and Technology is the custodial coordinator for the development of the NSI and influences this system through key strategies such as the National Research and Development Strategy (NRDS) and the Ten-Year Innovation Plan (TYIP). The latter, particularly, seeks to contribute to the transformation of the South African economy into a knowledge-based economy, in which the production and dissemination of knowledge will lead to socio-economic benefits and enrich all fields of human endeavour. NRDS Policy Framework.

Policy mandate

The Department's major policy documents are the *White Paper on Science and Technology (1996)*, the 2002 NRDS, the *New Strategic Management Model for South Africa's Science and Technology System (2004)* – with its Policy on Governance Standards for Science, Engineering and Technology Institutions and Framework for the Development of a National Science and Technology Expenditure Plan – and the 2007 TYIP.

In 2002, Cabinet approved the National Research and Development Strategy as the basis for the NSI. The Research and Development Strategy requires performance and responses in three key areas, namely enhanced innovation; providing science, engineering and technology human resources and transformation; and creating an effective government science and technology system.

The White Paper laid the foundations for an NSI. The core vision was to "harness the diverse aspects of science and technology through the various institutions where they are developed, practised or utilised".

A prime objective of the NSI was "to enhance the rate and quality of technology transfer from the science, engineering and technology sector by the provision of quality human resources, effective hard technology transfer mechanisms, and the creation of more effective and efficient users of technology in the business and government sectors".

In April 2012, South Africa and Germany launched the German-South African Year of Science in Cape Town. There are roughly 600 German companies in South Africa, constituting ideal places for graduates to get solid on-the-job training and experience.

The White Paper also set out the institutions to be established to promote the development of a well-functioning NSI. These were to be the national Ministry and Department of Science and Technology, the National Advisory Council on Innovation, the NRF, the Innovation Fund, and national research facilities managed by government.

National Research and Development Strategy (NRDS)

The NRDS is aimed at being a key enabler of economic growth alongside other strategies, such as the Human Resource Development Strategy, the Integrated Manufacturing Strategy and the Strategic Plan for South African Agriculture.

The NRDS is indicator-based and rests on three pillars, namely:

- innovation
- science, engineering and technology; human resources and transformation
- creating an effective government science and technology system.

The NRDS has established:

- a new set of technology platforms, including biotechnology; information technology; technology for advanced manufacturing; technology for and from natural resource sectors; and technology for poverty reduction
- a new set of science missions in areas in which South Africa has an obvious geographic advantage, such as astronomy; human paleontology and biodiversity; as well as in areas in which South Africa has a clear knowledge advantage, such as indigenous knowledge and deep mining.

National Science Week was celebrated from 30 July to 4 August 2012. Under the theme *The Role of Science and Technology in Economic Development*, activities took place at more than 89 sites, including science centres, across South Africa. The Department of Science and Technology distributed educational material such as science, engineering and technology career awareness information to help learners plan their careers.

Ten-Year Innovation Plan (TYIP)

The TYIP is aimed at assisting to establish a knowledge-based economy for South Africa, in which the production and dissemination of knowledge lead to economic benefits and enrich all fields of human endeavour.

The missions and platforms under the NRDS were expanded under the TYIP to include "grand challenges" in space science and technology, energy security, human and social dynamics in development, global change, and the bio-economy.

The responsibility for addressing the grand challenges is spread across many government departments.

The TYIP also set long-term goals based on the grand challenges it identified. They included:

- becoming one of the top three emerging economies in the global pharmaceutical industry, based on innovative use of South Africa's indigenous knowledge and rich biodiversity
- deploying satellites that provide a range of scientific, security and specialised services for all spheres of government, the public and the private sector
- achieving a 25% share of the global hydrogen and fuel cell market with novel platinum group metal catalysts
- becoming a world leader in climate science and responding effectively to the multiple challenges associated with global and climate change
- meeting the 2014 millennium development goal to halve poverty.

The department has set indicators for each of these goals.

Funding

The Department of Science and Technology was allocated R16,6 billion over the 2012 Medium Term Expenditure Framework (MTEF), of which R4,96 billion was for 2012/13. Of the total budget for the 2012/13 financial year, R2,6 billion or 53% was allocated to public entities, as follows:

- Academy of Science of South Africa (ASSAf): R13 million
- Aisa: R33 million
- CSIR: R737 million
- HSRC: R214 million
- NRF: R1 070 million
- Sansa: R95 million
- TIA: R455 million.

Of the remainder, R1,94 billion was allocated to department-directed projects (implemented by institutions that perform research and development) and R397 million to the running costs of the department. The allocations to public entities rose from R2,6 billion to R2,9 billion between 2012/13 and 2014/15, at an annual average growth rate of 5%.

For the first time since 1994, the Department of Science and Technology had a spending category for science and technology in the national Budget Review. This set out government's total financial commitment to all science and technology institutions. The proposed allocation was R10,7 billion in 2012/13, which was just over 1% of national expenditure.

Donor funding

The department received official development assistance (ODA) from Australia, Canada, the European Community, Finland, United States Agency for International Development (USAID) and Japan. Below is a brief summary of the science and technology activities supported by the ODA partners.

Australia

Australia has committed to regional support for the development and implementation of a science and technology policy training initiative for senior Southern African Development Community (SADC) officials, as well as for the

development of an SADC Science, Technology and Innovation Implementation Framework for Climate Change Response. The policy training is progressing well and the first training programme will commence in October 2012. The Science, Technology and Innovation Implementation Framework for Climate Change Response was completed. The total amount committed was R3 124 595.

Canada

The Epidemiological Modelling and Analysis in South Africa initiative includes financial support to the South African Centre of Excellence (CoE) in Epidemiological Modelling and Analysis of approximately R20 million over five years. The project aims to develop, in partnership with Statistics Canada and the World Health Organization, innovative quantitative methods to support a more integrated, evidence-based national response to HIV/AIDS (and major related diseases such as tuberculosis).

The project was initiated in November 2008 and was presented at the annual consultation between South Africa and Canada. The Director-General of the Canadian International Development Agency complemented the programme as a strategic intervention and said that more such initiatives should be considered.

The Canadian government has committed R6,892 million over three years (R2,498 million per year) for South Africa's participation in the Grand Challenge Canada call for point-of-care diagnostics to improve healthcare and life expectancy among South Africans.

European Union (EU)

Approximately R70 million was received by the South African NSI through the participation of South African researchers in the EU Framework Programme, including projects that are managed directly by Department of Science and Technology (CAASTNet, ESASTAP, INCONTACT, AeroAfrica EU and IST Africa).

The EU has allocated a total of €30 million to support the Department of Science and Technology in its poverty alleviation initiatives over a period of three years. This allocation will see the department supporting, among other things, the use of scientific innovation to provide sustainable water service delivery in rural areas, and the use of information and communication technologies (ICT) to develop and empower rural communities through employment creation and human capacity development.

Greece

SAccess assists EU researchers by identifying and highlighting the available opportunities for research collaboration through participation in South Africa's national research and innovation programmes. R300 000 was received from Greece.

Finland

The South Africa Finland Partnership (SAFIPA) was aimed at narrowing the digital divide by introducing interventions to help South Africa become an inclusive knowledge society with a strong ICT brand, reflecting research excellence and demonstrating improvements in quality of life and economic competitiveness. The Finnish contribution to this programme was R30 million over three years, disbursed at R10 million per year. The project was successfully closed in 2011/12.

The Finnish-South African Partnership Programme (BioFISA) is a three-year programme that is jointly funded by the Finnish government and the Department of Science and Technology to build biosciences research capacity in Southern Africa. The programme is managed by the Southern Africa Network for Biosciences (SanBio), and the programme office is based at the CSIR. SanBio, which is also supported by New Partnership for Africa's Development (Nepad), manages the funded projects in all biosciences nodes in Southern Africa.

The programme receives R30 million over three years, disbursed at R10 million per year.

United States of America (USA)

Ongoing support was provided by the USAID for two regional capacity development initi-

atives. The Potato Culture Project in Malawi is progressing well. Additional funding was provided by USAID for the procurement of a generator for the laboratory, as the unreliable electricity in the area was affecting the project negatively.

The SADC Risk and Vulnerability Atlas Capacity Development project will be completed early in the current financial year.

A new call was posted by USAID and the Department of Science and Technology was successful with three additional proposals. These proposals include another round of funding for the SADC Risk and Vulnerability Atlas Capacity Development, based on the good results achieved during the first phase, and two projects with Mozambique, one on aquaculture and another on joint research around the impact of pollution in the Oliphant's River on the health of communities living around the river.

France

France has committed another R14,850 million over three years (R4,95 million per annum) for the extension of the French-South African Institute of Technology (F'SATI) Scientific Director contract.

Japan

In respect of productivity training to increase the employability level of science and technology graduates, the technical assistant placed at the Department of Science and Technology at R1,7 million, was transferred to the Department of Higher Education and Training, as the pilot of the initiative was completed under the Department of Science and Technology leadership and the roll-out to other higher education institutions is the Department of Higher Education and Training's responsibility.

Volunteers were placed in Limpopo, the Eastern Cape and North West to support science centres with developing teaching material for science and mathematics education and to develop exhibitions to systematise the newly developed exhibitions to ensure knowledge gain by science centres.

Hitachi scholarships for two South African electrical engineers are valued at approximately R900 000. The total investment from Japan through ODA to Department of Science and Technology initiatives in 2011/12 amounted to approximately R17 million through in-kind and grant contributions.

Role players

Academy of Science of South Africa (ASSAf)

ASSAf was inaugurated in May 1996 by former President and patron of the Academy, Nelson Mandela. It was formed in response to the need for an academy of science congruent with the dawn of democracy in South Africa – activist in its mission of using science for the benefit of society.

The mandate of the academy encompasses all fields of scientific enquiry and it includes the full diversity of South Africa's distinguished scientists.

ASSAf is the official national academy of science in the country and represents the country in the international community of science academies.

Since its inception, ASSAf has grown remarkably from a small, emergent organisation to a well-established academy.

Africa Institute of South Africa (Aisa)

Aisa was first established in 1960 as a non-profit organisation. Today it is a statutory body following the Aisa Act, 2001. Aisa's mandate is to produce knowledge aimed at informing sustainable political and socio-economic development in Africa. Its vision is to be an indispensable African voice on African Affairs, and its 2011 – 2015 research agenda is to seek solutions for Africa's developmental challenges.

Through its annual training programme that educates students from universities in research methodologies, Aisa has contributed to fostering a new generation of research specialists.

The institute has also been able to produce some of the finest research on contemporary

South Africa is conducting trials involving unused parts of the television frequency spectrum to provide low-cost broadband internet. Aimed at ascertaining the feasibility of the technology, the trials were funded by Google in partnership with the Tertiary Education and Research Network of South Africa and the Council for Scientific and Industrial Research.

Television white spaces are unused spaces in the television spectrum that can be used for broadband. They offer the potential to improve internet connectivity. The trials are challenging since TV white spaces is an uncharted area and the supporting technologies are not readily available.

African Affairs by field research every year throughout Africa. This means that all research output is based on first-hand empirical evidence.

Aisia has also become involved in community outreach programmes by providing maps and other resources to under-privileged schools in rural areas. The institute has undertaken to promote knowledge creation as a fundamental part of development and growth for Africa. As such, it aims to encourage research as a career choice for young people as they leave school.

Council for Scientific and Industrial Research (CSIR)

The CSIR is one of the leading science and technology research, development and implementation organisations in Africa. The CSIR's main site is in Pretoria, while it is represented in other provinces of South Africa through regional offices.

The CSIR transfers the knowledge generated through research activities by means of technology and skilled people. The generation and application of knowledge reside at the core of the CSIR. This takes place in domains such as biosciences; the built environment; defence, peace, safety and security; materials science and manufacturing; and natural resources and the environment.

Emerging areas of research include areas of science, explored by the CSIR, that could be unique to local circumstances or successful internationally and need to be established for local competitiveness. Examples include nanotechnology, synthetic biology and mobile autonomous intelligent systems.

The CSIR houses specialist research facilities of strategic importance for African science. These include ICTs; laser technology; and space-related technology.

Research and development activities include intellectual property (IP) management, technology transfer (for commercial gain as well as for social good), knowledge dissemination and impact assessment.

Consulting and analytical services include forensic fire investigations, food and beverage analysis, environmental testing, engineering forensics, wire rope testing, mechanical testing, fire and explosion tests, sports technology and analysis, and project management.

Human Sciences Research Council (HSRC)

The HSRC conducts large-scale, policy-relevant, social-scientific projects for public-sector users, non-governmental organisations and international development agencies. This is done in partnership with researchers globally, but specifically in Africa. The HSRC serves as a knowledge hub to bridge the gap between research, policy and action; thus increasing the impact of research.

The HSRC's six multidisciplinary research programmes are:

- Education and Skills Development
- Economic Performance and Development
- Population Health, Health Systems and Innovation
- HIV and AIDS, sexually transmitted infections and tuberculosis (TB) (including the Africa-wide research network SAHARA)
- Democracy, Governance and Service Delivery
- Human and Social Development

The council's centres are the Centre for Science, Technology and Innovation Indicators; and the Centre for the Study of the Social and Environmental Determinants of Nutrition.

The HSRC Press is South Africa's only open-access publisher and is committed to the dissemination of high-quality, social-science research-based publications, in print and electronic form. HSRC Press publishes the research output of the HSRC as well as externally authored works.

National Advisory Council on Innovation (Naci)

Naci advises the Minister of Science and Technology on the role and contribution of innovation (including science and technology) in promoting and achieving national objectives, namely to:

- improve and sustain the quality of life of all South Africans
- develop human resources for science and technology
- build the economy
- strengthen the country's competitiveness in the international sphere.

The membership of Naci is broadly representative of all sectors and is constituted in a manner that ensures a spread of expertise and experience regarding:

- national and provincial interests
- scientific and technological disciplines innovation
- the needs and opportunities in different socio-economic fields
- research and development in all sectors.

National Research Foundation (NRF)

The NRF was established following a system-wide review conducted for the then Department of Arts, Culture, Science and Technology. The new entity incorporated the functions of the research funding agencies that were previously servicing various sections of the research community, namely the former Centre for Science Development of the HSRC and the former Foundation for Research Development that included several national research facilities.

As an independent government agency, the NRF promotes and supports research in all fields of knowledge. It also conducts research and provides access to national research facilities. The NRF provides services to the research community, especially at higher education institutions and science councils, with a view to promote high-level human capital development. The NRF aims to uphold excellence in all its investments in knowledge, people and infrastructure.

The NRF consists of three divisions namely: Risa, which constitutes the research support and promotion agency of the NRF; Saasta, which provides and manages cross-cutting activities that advances science and technology into various communities in South Africa; and the national research facilities that undertake research in specific research fields.

Through Risa, the NRF:

- invests in knowledge, people and infrastructure
- develops the workforce, particularly previously disadvantaged men and women, to help all researchers unlock their full creative potential
- facilitates partnerships and knowledge networks
- supports and provides science and technology information to guide and steer strategic decisions.

Through Saasta, the NRF:

- steers young minds towards careers in science and technology
- interacts with the public on science, engineering and technology issues
- communicates the advances of science and technology to the public.

Sunward Park High School in Boksburg is the first public school in South Africa to transform learning into a fully digital platform.

The Deputy Minister of Basic Education Enver Surty officially launched an E-learning Project in March 2013. The project was piloted in September 2012 under the guidance of Deputy Principal Enoch Thango, in partnership with MIB Technologies. Learners from grades 8 to 12 started using this digital platform at the beginning of the 2013 school year. A comprehensive portal with learning and teaching resources is available to them. They just log onto the school portal and download the specific textbooks for etheir grade and subject.

Through the national research facilities, the NRF:

- provides access to unique technologies, research methods and information
- provides state-of-the-art research platforms
- offers access to networking opportunities and international collaboration.

The NRF aims to contribute to the knowledge economy in South Africa by attaining at least 1% of global research and development output by 2015.

In 2012, the department aimed to increase support for national research facilities and the provision of research equipment. Some R525 million was allocated to national research facilities and R125 million for research equipment. The Minister of Science and Technology also mandated the NRF to increase support for emerging researchers and consider strategies for supporting women researchers.

South African National Space Agency (Sansa)

Sansa was created to promote the use of space and cooperation in space-related activities while fostering research in space science, advancing scientific engineering through developing of our human capital and provide support to industrial development in space technologies.

The objectives of SANSA are to:

- promote the peaceful use of space
- support the creation of an environment conducive to industrial development in space technology
- foster research in space science, communications, navigation and space physics
- advance scientific, engineering and technological competencies and capabilities through human capital development outreach programmes and infrastructure development
- foster international cooperation in space-related activities.

Technology Innovation Agency (TIA)

The TIA was established with the objective of stimulating and intensifying technological innovation to improve economic growth and the quality of life of all South Africans by developing and exploiting technological innovations.

Its core business objective is to support the development and commercialisation of competitive technology-based services and products. The agency primarily uses South Africa's science and technology base to develop new industries, create sustainable jobs and help diversify the economy. It invests in the following technology sectors: advanced manufacturing, agriculture, industrial biotechnology, health, mining, energy and ICT.

TIA was formed through merging seven Department of Science and Technology entities previously tasked with supporting and promoting innovation in the country. These entities included the Innovation Fund, Tshumisano Trust, Cape Biotech Trust, PlantBio Trust, LIFElab, BioPAD Trust, and the Advanced Manufacturing Technology Strategy.

The agency seeks to achieve its mandate by providing financial and non-financial support to its stakeholders, namely science councils, public entities, higher education Institutions, private research institutions and entrepreneurs.

National Intellectual Property Management Office (Nipmo)

Nipmo was established in mid-2011 in terms of the IPR Act, 2008 to promote and manage the objects of the Act. These include the identification, disclosure and statutory protection, and management and commercialisation of the intellectual property referred to it by a recipient of public research and development funds. Nipmo has been set up as an interim office within the Department of Science and Technology as a sub-programme within Programme 2 – Research Development Innovation, pending its establishment as a government component within a two-year time frame.

Nipmo aims to ensure that recipients of funding from a government funding agency assess, record and report on the benefit to society of intellectual property emanating from publicly financed research and development.

Recipients must protect intellectual property emanating from publicly financed research and development from appropriation and ensure that it is available to the people of South Africa. A recipient must identify commercialisation opportunities for intellectual property emanating from publicly financed research and development.

Agricultural Research Council (ARC)

The ARC is the principal agricultural research institution in South Africa. It conducts fundamental and applied research with partners to generate knowledge, develop human capital, and foster innovation in agriculture by developing technology and disseminating information. It also commercialises research results.

The ARC's functions are carried out through 11 research institutes whose activities are grouped under five divisions:

- field crops (grain and industrial crops)
- horticulture
- animal production and health
- natural resources and engineering
- technology transfer.

The ARC is also responsible for maintaining national assets and undertaking programmes or rendering services that are required from time to time by the department and other stakeholders.

Mintek

Mintek, South Africa's national mineral research organisation, is one of the world's leading technology organisations specialising in mineral processing, extractive metallurgy and related areas. Working closely with industry and other research and development institutions, Mintek provides service testwork, process development and optimisation, consulting and innovative products to clients worldwide.

Mintek is an autonomous statutory organisation, which reports to the Minister of Minerals and Energy. About 35% of the annual budget is funded by the State Science Vote, with the balance provided by contract research and development, sales of products and services, technology licensing agreements, and joint-venture private-sector companies. Mintek has about 780 permanent staff members, more than half of whom are scientists, engineers and other technical research and development specialists.

The Department of Mineral Resources granted Mintek R90 million over the 2011/14 period for the rehabilitation of derelict and ownerless mines in South Africa.

Medical Research Council (MRC)

The MRC is an independent statutory body that coordinates health and medical research activities throughout South Africa. The MRC's objectives are:

- promoting health and quality of life of the population of South Africa
- performing such functions as may be assigned to the MRC by or under the MRC Act, 1991 (Act 58 of 1991).

The MRC is a science council and therefore also a science, engineering and technology institution.

Council for Geoscience (CGS)

The CGS is the legal successor of the Geological Survey of South Africa, which was formed in 1912 by the amalgamation of three former surveys, the oldest of which – the Geological Commission of the Cape of Good Hope – was founded in 1895.

The Geoscience Amendment Act, 2010 (Act 12 of 2010), amends the Geoscience Act, 1993 to mandate the CGS to be the custodians

South African microbiologist, Prof. Leon Dicks, and a research team from Stellenbosch University has applied modern technology and science to develop a revolutionary dressing to treat burn wounds. The new dressing is the first of its kind and will reduce the risk of secondary infections.

The dressing offers a solution to antibiotic resistance, using antimicrobial peptides and nanofibres. The dressing also releases antimicrobial peptides slowly over several days, which means it only has to be changed once a week. By altering the nanoparticles, the dressing becomes part of the new skin and supports the healing process.

of geotechnical information; to act as a national advisory authority in respect of geohazards related to infrastructure and development; and to undertake exploration and prospecting research in the mineral and petroleum sectors.

South African Bureau of Standards (SABS)

The SABS is a statutory body that operates as the national institution for the promotion and maintenance of standardisation and quality in connection with commodities and the rendering of services. The SABS:

- publishes national standards, which it prepares through a consensus process in technical committees
- provides information on national standards of all countries as well as international standards
- tests and certifies products and services to standards
- develops technical regulations (compulsory specifications) based on national standards, and monitors and enforces compliance with such technical regulations
- monitors and enforces legal metrology legislation
- promotes design excellence
- provides training on aspects of standardisation.

To maximise its service delivery to the industries it serves, the SABS aligned its activities with seven different industry sectors, each housing the whole range of the SABS services pertinent to a particular industry.

This change ensures easy access to products, faster reaction and turnaround times, and the creation of centres of knowledge excellence that will be easily available to clients.

The seven industry sectors are:

- chemicals
- electrotechnical
- food and health
- mechanical and materials
- mining and minerals
- services
- transportation.

Other scientific and research organisations and structures

Eskom

Eskom's Technology Services International group is a multidisciplinary industrial laboratory and consulting organisation. It undertakes testing, investigation studies, project management, engineering services and applied research for Eskom and other customers.

Sasol

Sasol's culture of innovation began in the 1950s when it developed its unique blend of coal gasification and Fischer-Tröpsch (FT) technology for its original coal-to-liquids operations at Sasolburg. It has since evolved these operations into fully fledged research and development facilities that form the heart of the Sasol technology research and development group. Focused FT research and development in the 1980s and 1990s led to the development of the low temperature FT Sasol Slurry Phase process used at Sasolburg, and the high-temperature Sasol Advanced Synthol™ process used at Secunda.

Sasol Technology's Fuels Technology Division carries out work concerning fuels, lubricants, heating-fuel and road-binding material, research and development, and new product formulation and testing.

In addition, Sasol opened the Sasol Fuels Application Centre (SFAC), a state-of-the-art engine and exhaust emission testing and research facility in Cape Town. The SFAC enables Sasol to conduct sea-level engine and emission tests in line with international standards.

In October 2011, the Department of Science and Technology and Sasol ChemCity launched a plant oils and extracts facility in Tzaneen, Limpopo, in an effort to create sustainable livelihoods in the area. The Nkowankowa Demonstration Centre will run a R13,9-million development project over the next three years, extracting various fruit and plant oils with a view to establishing their viability in the cosmetics sector.

ArcelorMittal

ArcelorMittal is a global steel-maker, with an industrial presence in 27 countries. It is the leader in all major global markets, including automotive, construction, household appliances and packaging. The group is a leader in research and development and technology, holds sizeable captive supplies of raw material, and operates extensive distribution networks.

National Health Laboratory Service (NHLS)

The NHLS forms a national network of integrated pathology laboratories throughout the country that use common laboratory management systems and transport networks to facilitate the transport of specimens, referral of tests to reference laboratories, and delivery of results.

The NHLS has 265 laboratories and employs about 6 500 people. Their activities comprise diagnostic laboratory services; research, teaching and training; and producing sera for anti-snake venom, reagents and media. All laboratories provide laboratory diagnostic services to the Department of Health, provincial hospitals, local authorities and medical practitioners.

Research conducted by the NHLS covers a wide spectrum of activities in all pathology disciplines. Grants in support of research are made by the MRC, the Cancer Association of South Africa, the South African Sugar Association, Poliomyelitis Research Foundation, pharmaceutical companies, private donors and a number of overseas institutions, among others. A large part of the research programme is financed by the NHLS itself from the earnings of its laboratory services.

Bureau for Economic Research (BER)

The BER at the University of Stellenbosch, Western Cape, is an independent economic research organisation. It renders a service to organisations ranging from small one-person businesses to policy-makers at the highest level of government.

National Institute for Tropical Diseases

The National Institute for Tropical Diseases in Tzaneen, Limpopo, is responsible for the ongoing assessment of malaria-control programmes carried out by various authorities in South Africa.

Control methods are assessed and recommendations made to the appropriate authorities regarding equipment, insecticide usage and application. A malaria-reference service is also provided. Malaria tests are carried out by the institute, and statistical analyses of data pertaining to the programme is undertaken.

Institute for Economic Research on Innovation (Ieri)

Ieri was established as a public-good research organisation with a core competence in the analysis of systems of innovation. Its mandate is to provide research, capacity-building and community engagement in this field of study. Its tasks involve:

- conducting research on the political economy and policy dimensions of innovation and development
- contributing thought-leadership on the relationship between knowledge and development across economic, social and political domains
- building capabilities and competencies in the understanding of the political economy and policy dimensions of innovation and development
- focusing across local, provincial, national, regional and international geographies.

Institute for Security Studies (ISS)

The ISS works towards a stable and peaceful Africa characterised by sustainable development, human rights, the rule of law, democracy, collaborative security and gender mainstreaming.

The ISS realises this vision by:

- undertaking applied research, training and capacity-building
- working collaboratively with others
- facilitating and supporting policy formulation
- monitoring trends and policy implementation

- collecting, interpreting and disseminating information
- networking on national, regional and international levels.

South Africa's National Energy Development Institute (Sanedi)

Sanedi was established in 2012 through the merger of the South African National Energy Research Institute and National Energy Efficiency Agency.

The Department of Science and Technology and the Department of Minerals and Energy are joint custodians of Sanedi and assist in providing political and strategic focus for the company.

The institute is entrusted with the coordination and undertaking of public interest energy research, development and demonstration. As such, it is responsible for enabling and implementing the energy technology roadmaps which support long-term energy policies developed by the Department of Energy.

Safety in Mines Research Advisory Committee

The activities of the Safety in Mines Research Advisory Committee are aimed at advancing the safety of workers employed in South African mines.

The committee is a statutory tripartite subcommittee of the Mine Health and Safety Council. It has a permanent research-management office managing the rock engineering, engineering and mine occupational health fields of research.

National Agricultural Research Forum (Narf)

The NARF coordinates agricultural research and development within the national agricultural research system. It also provides a platform for stakeholder consultations on research and development matters. Biannual meetings are held to debate and agree on research needs, programmes and budgeting. Efforts are made to ensure that the bulk of research serves the needs of small-scale producers.

Research initiatives have been integrated into the various industries in line with the overall objectives of each agricultural sector.

Water Research Commission (WRC)

The WRC was established in 1971 following a period of water shortages. The WRC is responsible for:

- promoting coordination, cooperation and communication in the area of water research and development
- establishing water-research needs and priorities
- stimulating and funding water research according to priority
- promoting the effective transfer of IT
- enhancing knowledge and capacity-building within the water sector.

The WRC focuses on five key strategic areas:

- water-resource management
- water-linked ecosystems
- water-use and waste management
- water-use in agriculture
- water-centred knowledge.

The main areas of research are surface hydrology, groundwater, hydrometeorology, agricultural water-use, water pollution, municipal effluents, industrial water and effluents, drinking water, membrane technology, water ecosystems, hydraulics, mine-water management, water policy, developing communities and the transfer of technology.

Institute for Water Research (IWR)

The IWR is a multidisciplinary research department of Rhodes University. Its main objective is to contribute to sustainable water-resource management in southern Africa.

This is achieved through scientific research into the structure and function of aquatic ecosystems; the application of research through specialist consultancy services; tertiary-level teaching and training; capacity-building for community development; and service on national and international management and policy-making committees.

South African National Biodiversity Institute (Sanbi)

Sanbi's biodiversity research comprises collaborative programmes set up to promote and catalyse knowledge about biodiversity.

The broad scope of research includes the origins, composition and functioning of biodiversity, its conservation and sustainable use, ecosystem services, and biodiversity responses to major drivers such as climate change. The research is organised into three divisions:

- Applied Biodiversity Research
- Biosystematics Research and Biodiversity Collections
- Climate Change and Bio-Adaptation.

Coastal and marine research

The NRF supports marine and coastal research in partnership with the Department of Environmental Affairs and the South African Network for Coastal and Oceanic Research. The Chief Directorate: Marine and Coastal Management advises on the use of marine living resources and the conservation of marine ecosystems, by conducting and supporting relevant multidisciplinary scientific research and by monitoring the marine environment.

Sustainable use and the need to preserve future options in using marine ecosystems and their resources are guiding objectives in the research and advice provided by the chief directorate.

National research facilities

The seven national research facilities managed by the NRF are clustered on the basis of their areas of specialisation aligned to the science missions of the NRDS.

South African Astronomical Observatory (SAAO)

SAAO is the national centre for optical and infrared astronomy in South Africa. Its prime function is to conduct fundamental research in astronomy and astrophysics by providing a world-class facility and by promoting astronomy and astrophysics in southern Africa.

Researchers and physics students at the University of Johannesburg (UJ) are now part of a team of more than 400 scientists and scholars from 90 universities and laboratories across 19 countries on six continents, working to unveil the mysteries of the high-energy universe. In March 2013, UJ became the newest member institute of NASA's Fermi-LAT gamma-ray space telescope mission. The telescope orbits planet Earth every 95 minutes, building up deeper views of the universe with every circuit. Since non-thermal, relativistic particles are responsible for both gamma-ray and radio emission, Fermi-LAT science is complementary to the science of the Square Kilometre Array Radio Telescope (SKA), which will be hosted by South Africa.

The SAAO contributes to the future development of South Africa through the creation and dissemination of scientific knowledge, through the provision of research infrastructure, and through providing an interface between science and society.

It is also responsible for managing the operations of the South African Large Telescope (Salt).

Hartebeesthoek Radio Astronomy Observatory (HartRAO)

The HartRAO is a radio astronomy observatory located in a natural bowl of hills at Hartebeesthoek just south of the Magaliesberg mountain range, Gauteng, South Africa, about 50 km west of Johannesburg. It is a national research facility run by South Africa's NRF and is the only major radio astronomy observatory in Africa.

HartRAO is mainly used for continuum radiometry, spectroscopy, pulsar timing and interferometry but also works together with radio telescopes on other continents as well as the orbiting radio telescope HALCA (or the Highly Advanced Laboratory for Communications and Astronomy) to perform Very Long Baseline Interferometry (VLBI).

South African Institute for Aquatic Biodiversity (Saiab)

Situated in Grahamstown in the Eastern Cape,

Saiab is an internationally recognised centre for the study of aquatic biodiversity. Saiab runs a number of large, interdisciplinary and multi-institutional programmes. The research facility is directed at fish taxonomy, systematics, genetics, phylogeography, biology, ecology, ethology, conservation, and fisheries management.

South African Environmental Observation Network (Saeon)

Saeon is a research facility that establishes and maintains nodes (environmental observatories, field stations or sites) linked by an information management network to serve as research and education platforms for long-term studies of ecosystems that will provide for incremental advances in our understanding of ecosystems and our ability to detect, predict and react to environmental change.

The core research programme will strive to distinguish between anthropogenic and natural change as well as to unravel the relations between social change and ecosystem change.

National Zoological Gardens (NZG)

Inspired conservation of wildlife through understanding, knowledge and connection, as the vision and mission statements, reflect a commitment by the NZG to bridge the gap between nature and humanity through the provision of a platform on which humanity can gain knowledge about, cultivate a better understanding of and connect with nature in general, but wildlife in particular.

iThemba Laboratory for Accelerator-Based Sciences

iThemba LABS is a multidisciplinary facility aiming to become the leading African organisation for research, training and expertise in accelerator-based science and technologies. The infrastructure is based at two sites, namely in the Western Cape, on Old Faure Road, and in Gauteng, on the campus of the University of the Witwatersrand.

Research areas

Biotechnology

South Africa's research institutions and universities are conducting biotechnology research to increase production of crops suited to local conditions, enhance crop nutritional value and improve preservation and processing methods resulting in novel and improved food products.

Research is being conducted into understanding the nutritional components of food indigenous to South Africa, with the aim of making those with a high nutritional value available and accessible to most people.

Within the biotechnology space, South African researchers are doing the country proud. This is especially true in the area of tuberculosis research, where local researchers are working closely with national institutes of health in drug discovery and development of new potential drugs. The work being conducted at the University of Cape Town and at the CoE for Biomedical Tuberculosis Research, at Stellenbosch University and at the National Health Laboratory Services, are world class.

South Africa is classified as one of the 14 mega-biotech countries in the world, and the only one in Africa. These countries have a special responsibility to ensure that the potential impact of genetically modified organisms on human or animal health and on the environment; together with their probable socio-economic impact; are carefully measured, assessed and estimated before they are released, thus ensuring a favourable risk-benefit ratio.

The objective of the Department of Science and Technology, as stated in the Biotechnology Strategy, is to establish a sustainable and competitive biotech industry, which will result in the development of safe and beneficial products.

The biotechnology sector is attracting a fast-growing portion of research and development funding. South Africa is also committed to developing biotechnology in Africa.

Other initiatives include the establishment of biotechnology regional innovation centres

(Brics), namely the Biopad, Cape Biotech, LIFElab and the Plant Biotechnology Innovation Centre. Brics were created as instruments for implementing the National Biotechnology Strategy, and cover a wide spectrum of subdisciplines in biotechnology. These include human and animal health, biopharmaceuticals, industrial bioprocessing, mining biotechnology, bioinformatics and plant biotechnology. TIA has absorbed the Brics and will significantly expand on the innovation development portfolios.

The Department of Science and Technology has launched the Public Understanding of Biotechnology Programme to ensure a clear and balanced understanding of the scientific principles, related issues and potential of biotechnology, and to stimulate public debate around its applications in society.

Biosafety

The aim is to make South Africa one of the top three emerging economies in the world in terms of the pharmaceutical, nutraceutical, flavour, fragrance and biopesticide industries by 2018.

Biosafety relates to the avoidance of risk to human and animal health, safety and prosperity, and to the environment, when researching, developing and commercialising the products of modern biotechnology.

The vision of Biosafety South Africa is to support innovation in biotechnology by ensuring the development of safe and sustainable biotechnological products. It promotes the biosafety of biotechnological products through the delivery of value-adding services and investment in strategic biosafety research.

Biosafety South Africa has:

- established firm collaborative partnerships with various international role players in biosafety, including the International Centre for Genetic Engineering and Biotechnology, the Biosafety Resource Network of the Donald Danforth Plant Science Centre and Nepad's African Biosafety Network of Expertise
- developed and commissioned a wide range of strategic biosafety research projects and committed more than R5 million over the 2011 to 2013 period to strategic biosafety research
- established new capacity in South Africa for biosafety research by investing in research groups that had not previously undertaken any biosafety research, and funded 11 postgraduate bursaries.

In the delivery of the National Biotechnology Strategy, the Department of Science and Technology has set up the necessary instruments to drive biotechnology's commercialisation, a series of technology platforms to enable biotechnology development, and a range of capacity development initiatives to ensure there is human capital for the growing sector.

Astronomy and the Square Kilometre Array (SKA)

South Africa continues to promote high-technology investment to ensure that local researchers and students are able to participate in international astronomy.

As a region, southern Africa is already internationally recognised in the area of astronomy. The region has major astronomy facilities that include the Southern African Large Telescope (Salt) in the Northern Cape and the HESS gamma-ray telescope in Namibia.

Salt was launched in November 2005, in Sutherland in the Northern Cape. This multimillion-rand project involving Germany, Poland, the USA, New Zealand and the United Kingdom (UK), is the largest single optical telescope in the southern hemisphere.

In May 2012, the SKA Organisation announced that South Africa and Australia were to jointly host the SKA.

SKA South Africa is joining IBM and the Netherlands Institute for Radio Astronomy (Astron) in a four-year collaboration to research extremely fast but low-power "exascale" computer systems. These systems are aimed at developing advanced technologies for handling the massive amount of data that will be produced by the SKA.

As part of this collaboration, South African scientists will be involved in exploring new computer architectures, developing advanced algorithms for radio astronomy imaging, and developing rugged microservers capable of handling harsh desert conditions.

Despite the dual site approach, the majority of the SKA – the full dish array and the dense aperture array – will be built in Africa. The core, i.e. the region with the highest concentration of receivers, will be constructed in the Northern Cape about 80 km from the town of Carnarvon (the same site where the MeerKAT is being constructed). The sparse aperture array (low-frequency array) will be built in Western Australia.

South Africa has already demonstrated its excellent science and engineering skills by designing and starting to build the MeerKAT telescope – as a pathfinder to the SKA. The first seven dishes, KAT-7, are complete and have already produced its first pictures. MeerKAT is attracting great interest internationally – more than 500 international astronomers and 58 from Africa submitted proposals involving MeerKAT once it is complete.

The technology being developed for MeerKAT is cutting edge and the project is creating a large group of young scientists and engineers with world-class expertise in the technologies which will be crucial in the next 10 to 20 years, such as very fast computing, very fast data transport, large networks of sensors, software radios and imaging algorithms.

Since 2005, the African SKA Human Capital Development Programme has awarded close to 400 grants (2012) for studies in astronomy and engineering from undergraduate to post-doctoral level, while also investing in training programmes for technicians.

Astronomy courses are being taught as a result of the SKA Africa Project in Kenya, Mozambique, Madagascar and Mauritius (which has had a radio telescope for many years) and are soon to start in other countries.

Immediate benefits are in the form of research and development opportunities during the design phase. Scientists from universities across the continent have an opportunity to participate in the design of SKA novel technologies and instrumentation.

The construction phase of the SKA will generate localised direct benefits in the form of jobs, procurement and sourcing of local materials in each of the partner countries. A combination of these benefits will contribute to improvement in the sub-Saharan gross domestic product (GDP).

In addition to the immediate or short-term benefits, there are numerous long-term benefits accruable to the general community at large. Owing to the scientific nature of the project, the main benefit will be the improvement of the skills base and access to top international research facilities and networks which, in turn, will boost output of scientific publications.

In addition, the SKA science provides opportunities for the development of new algorithms and underlying mathematics for manipulating large datasets, new imaging technologies and techniques and new ICT skills beyond what is currently available. These are essential skills, which may be applied in other productive sectors of the economy.

The African Ministerial Council on Science and Technology recognised the SKA as a flagship project. The whole of the Northern Cape, excluding Sol Plaatje Municipality, has been declared an astronomy advantage area for optical and radio-astronomy purposes in terms of Section 5 of the Astronomy Geographic Act, 2007 (Act 21 of 2007).

Five new research chairs dedicated to the SKA project were created at leading South African universities and filled by international astronomers and cosmologists, with funding for 15 years committed to these.

Some of the SKA's African partners are doing valuable work building new telescopes or converting redundant satellite telecommunication antennae to establish what will be known as Africa's VLBI network.

VLBI is significant for imaging cosmic radio sources, or for applications in astrometry. It can also be used to map the movements of the Earth's tectonic plates precisely. When used in conjunction with other economically beneficial facilities such as global positioning systems, VLBI networks can improve the accuracy of surveying and mapping in a country.

For this reason, South Africa is assisting Ghana with the construction of a radio tele-

scope using a communications antenna that was acquired by the Ghanaian Government. The radio telescope is expected to boost post-graduate research and teaching programmes in radio astronomy.

Nanotechnology

Nanotechnology, unlike other technologies, can find applications in virtually all areas of human life. In spite of it being in its beginning stages, some of the known issues related to nanotechnology suggest a wide spectrum of potential societal impact. For a society to switch from a merely passive, observational role to one of active participation, public discourse about nanotechnology must be encouraged.

Known as "the technology of the very small" (that is about 1/80 000 of the diameter of a human hair), nanotechnology comprises a wide range of technologies, techniques and multidisciplinary research efforts for application in a range of cross-cutting industries and activities. These include aerospace, the manufacturing and automotive industries; energy conversion, storage and distribution; the hydrogen economy; chemicals; electronics and information processing; as well as biotechnology and medicines.

The Department of Science and Technology has stepped up investment in emerging research areas in general and the National Nanotechnology Strategy in particular. Two nanotechnology innovation centres were established at the CSIR and Mintek. The two nano innovation centres have a budget of R134 million over the current MTEF.

In 2011, the department acquired a world-class, R30-million high-resolution transmission electron microscope that was expected to be be commissioned in the latter part of the year.

The state-of-the-art electron microscope, one of just 15 in the world and the first in Africa, is housed in the new R120-million Centre for High-Resolution Transmission Electron Microscopy (HRTEM) at Nelson Mandela Metropolitan University in Port Elizabeth.

The Japanese-made instrument is the most powerful high-resolution microscope in Africa, enabling scientists to analyse materials down to atomic level, and making the university a new continental hub for nanoscience research.

The analytical attachments of the instrument make it very versatile, with applications ranging across fields as diverse as materials engineering, metallurgy, chemistry, zoology, geology and botany.

The HRTEM was established in collaboration with the NRF; the departments of science and technology, and higher education and training; and Sasol.

The National Nanotechnology Strategy focuses on nanotechnology in the area of health as one of its goals. This is the Mintek nano centre's speciality. It has already developed prototype point-of-care diagnostic tools for diseases such as TB and malaria.

In addition, there are several flagship projects in some of the country's nanotechnology development programmes. In particular, there is the nanotechnology-based TB drug-delivery system, a project led by the CSIR.

The project seeks to address the challenges of the current TB treatment regimen, with the ultimate goal of reducing the frequency and quantity of dosages. This will also reduce the cost of treatment. Through this project, existing TB drugs will be encapsulated into a biodegradable nano-polymer for slow release in the system.

By March 2011, the CSIR and the project team had successfully encapsulated all four first-line TB drugs in a nano-polymer using a technology they patented. With the project conducting clinical trials, prospects for success are looking good. The novelty of the project and its commendable progress saw the team receiving several awards, including a grant from the Bill & Melinda Gates Foundation.

As far as safety is concerned, South Africa has embarked on processes for the establishment of a nanotechnology risk-identification-and-mitigation research platform.

Palaeosciences

The palaeosciences are areas in which South Africa has a geographical advantage, owing

to the quantity and diversity of finds within its national borders.

The South African Strategy for the Palaeosciences (2011) identifies the field of palaeosciences as inclusive of the disciplines of palaeontology, palaeo-anthropology, archaeology, and related disciplines. These are the scientific disciplines that tell the story of life on Earth, including the story of humankind.

Research in the palaeosciences has profound relevance to all people, and is central to the recent emphasis on heritage development by the South African Government. There is without doubt no other country that has such a complete, endless terrestrial rock record covering the Carboniferous, Permian, Triassic and Jurassic periods documenting a climatic shift from glacial polar conditions to subtropical desert. The Karoo Sequence Studies hold clues to understanding both the end-Jurassic and end-Permian extinctions.

Targeted interventions and their systematic introduction aimed at strengthening research capacity in the palaeosciences "to generate a dynamic research environment and create the maximum intellectual vibrancy within these disciplines" are thus a priority for the Department of Science and Technology and the country as a whole.

Mandela 27 is a multimedia project that will bring the tales of Robben Island to life digitally. The project aims to highlight the social events that influenced change in South Africa and Europe during the former South African president's 27 years in prison.

Launched at Cape Town's Gateway to Robben Island, it will draw on cultural links between South Africa and Europe during the apartheid era.

Mandela 27 partners are the Robben Island Museum, Britain's Coventry University, the EU's Cultural Programme, Belgium's Creative Stories Project, and Elderberry, a content developer. Most of the stories will be told through an interactive website with a map interlinking events of activism in South Africa and Europe. The game and other digital components will be ready by February 2014, while the cell will start travelling in May 2014.

One such intervention is the establishment of a CoE in Palaeosciences that integrates palaeontology, palaeo-anthropology, archaeology and related disciplines to create interdisciplinary research and develop the necessary human capital.

Although the CoE will focus on existing institutional excellence, capacity has been rapidly diminishing in South African research areas such as invertebrate palaeontology, micropalaeontology, palynology (including pollen and phytolith analysis), taphonomy and geochronology (which includes isotope analysis and palaeoscience conservation).

These areas need to be strengthened. The CoE in Palaeosciences will also address these research areas and methodologies to ensure their continuity.

The NRF has therefore called for proposals from all publicly funded research institutions and higher education institutions to host the Department of Science and Technology-NRF CoE in Palaeosciences. The host institution will collaborate with other South African public research institutions in pursuance of the objectives of the CoE.

Information and communication technology (ICT)

The Department of Science and Technology is leading the implementation of the national ICT Research Development and Innovation (RDI) Strategy. Its main purpose is to create an enabling environment for the advancement of ICT RDI in South Africa.

South Africa's research capacity in the ICT field has become a strong competitive advantage. Since the beginning of 2011, the Department of Science and Technology has announced targeted partnerships with global ICT companies including SAP, Microsoft, and Nokia. These companies invested over R15 million in kind and cash in the department's ICT research and development programme in 2011/12, which was matched by departmental funds. In 2012/13, the department provided more funding to leverage increased direct international support for ICT research and

innovation. It also announced a partnership with IBM and Astron.

The ICT RDI Strategy aims to achieve a marked increase in advanced HR capacity, promote world-class research and build robust innovation chains for the creation of new high-tech ICT small enterprises. Implementing the strategy demands partnership involving government, the private sector, higher education institutions and science councils.

The Meraka Institute of the CSIR manages and coordinates the implementation of the strategy. An important envisaged outcome is a vibrant, sustainable and innovative indigenous ICT industry that addresses a significant portion of the country's ICT needs and attracts investments by overseas-based multinational ICT corporations in RDI and manufacturing facilities and resources in South Africa.

The Centre for High-Performance Computing (CHPC), Sanren and the Very Large Databases are the three pillars of cyberinfrastructure that the Department of Science and Technology supports. Hosted by the University of Cape Town and managed by the CSIR's Meraka Institute, the CHPC was the first of its kind in South Africa and is making scientific supercomputing a reality for South Africa.

It supports a diverse base of researchers and scientists, and facilitates the collaboration and multidisciplinary approach needed to solve complex computational problems, advancing South Africa's research capabilities in areas such as advanced manufacturing, space science and research into infectious diseases.

The high-speed computational infrastructure has 50 terabytes of storage space and 160 computer nodes (640 processors) in a clustered architecture. It has a peak performance of around 2,5 teraflops per second.

Sanren, which is responsible for the roll-out of a high-speed broadband network to all academic and research institutions in the country, was awarded a private electronic communications network licence exemption under the Electronic Communications Act, 2005 (Act 36 of 2005).

A major project for Sanren is the national backbone network, which aims to connect all major metros in the country with a 10 gigabyte per second link. Phase 1 of this project was completed in November 2011, linking Salt in Sutherland and the proposed SKA site with Cape Town.

In 2011/12, Sanren was extended to 107 institutions. In 2012/13, R78 million was allocated to extending connections to rural sites, including the final six higher education institutions that were unconnected. On completion, the network will reach about 200 sites, both nationally and internationally.

The overall network architecture will consist of a national backbone connecting Durban, Pretoria, Johannesburg, Bloemfontein, Cape Town, Port Elizabeth and East London; with metro rings in Johannesburg, Tshwane, eThekwini and Cape Town.

Researchers from South Africa's CSIR developed the world's first injectable medicine from a tobacco plant – an antidote for rabies which could change the way the deadly viral disease is treated worldwide.The new liquid antidote, RabiVir, is made from the leaves of the *Nicotiana benthamiana* plant, a cousin of the commercial cigarette tobacco plant *Nicotiana tabacum*.

Through genetic engineering, antibodies known to work against rabies were introduced to the *N. benthamiana* tobacco variety.The product is a collaborative effort of CSIR scientists, the World Health Organization (WHO), Kentucky Bioprocessing and MAPP Biopharmaceuticals.

Indigenous knowledge systems (IKS)

In November 2004, Cabinet adopted an Indigenous Knowledge System Policy to serve as a guide for the recognition, understanding, integration and promotion of South Africa's wealth of indigenous knowledge resources. One of the areas of action identified by the policy is the protection of indigenous knowledge and the holders of such knowledge against exploitation. This includes ensuring that communities receive fair and sustained recognition and, where appropriate, financial remuneration for the use of this knowledge

The indigenous knowledge of many com-

munities embodies a deeply spiritualised and ancient relationship with the Earth's systems and cycles.

Traditional songs and languages, clothing, architecture, foods, motifs, daily rituals and mythological epics contain local survival information. Moreover, the diversity of indigenous cultures provides unique insights into how to live harmoniously within nature.

By sharing indigenous stories of vulnerability and adaptation, people learn how communities share ideas on how ancestral wisdom is being incorporated into climatic adaptation strategies. By cherishing the value of indigenous knowledge, people can discover how best to adapt to a changing climate.

The Department of Science and Technology has three IKS priorities.

- The development of a regulatory environment for the protection of IKS.
- The development of the National Recordal System for the collection, recording, documenting, storage and management and dissemination of IKS in communities in the nine provinces of the country. Until orally transmitted and rapidly disappearing indigenous knowledge is recorded, it will be difficult to protect. The National Recordal System is the largest fingerprint initiative of the region to document and record indigenous knowledge. In addition to the establishment of IKS documentation centres in KwaZulu-Natal and Limpopo, an IKS documentation centre was also expected to be established in the Moruleng area by the end of 2011. The department aims to have established IKS documentation centres in all the provinces by 2013.
- Applied research, specifically bio-prospecting activities. An example would be how, with funding from the NRF, the MRC is developing the Moritela Tshwene Tea Project near Zeerust in the North West, with the aim of producing a nutritional herbal tea for the commercial market.

The Department of Science and Technology has put in place validation systems within its science system to ensure that indigenous knowledge products are safe and backed by the best science in the world. To give further impetus to these critical initiatives, the department has set aside a dedicated fund to support research into indigenous knowledge.

Two indigenous knowledge research chairs have been awarded as part of the country's Research Chairs Initiative (SARChI). The first was awarded to the University of KwaZulu-Natal for work in the field of traditional medicines. The second was awarded to Walter Sisulu University. These two chairs represent significant injections into the development of national research capacity in IKS.

The Department of Science and Technology also established an indigenous knowledge studies CoE at the universities. The centres will play a defining role in generating highly qualified HR capacity in IKS.

Private-sector involvement

South Africa's gold-mining industry works at deeper levels and under more difficult conditions than any other mining industry in the world. The research into gold mining conducted by the CSIR's Mining Technology Group is concerned primarily with ensuring the health and safety of the workforce. It includes those working in the areas of rock engineering and the underground environment.

Mining Technology's coal-mining research takes place on a smaller scale than that of gold mining, because the coal-mining industry is able to make use of various developments overseas. Areas in which research is undertaken include strata control, mining, maximising the extraction of coal, and the underground envir-onment.

Research is also carried out by a large number of industrial companies with facilities to meet their specific needs.

The more important ones are the:

- Anglo American Corporation of South Africa (applied metallurgy, processing of precious metals, base metals and coal)
- Agricura (synthesis and testing of veterinary remedies, insecticides, herbicides and entomology)

- Cullinan Holdings (refractories and electrical porcelain)
- De Beers Industrial Diamond Division (manufacturing and application of synthetic diamonds and other super-hard material)
- Johannesburg Consolidated Investment Company (metallurgy, mineralogy, chemistry and chemical engineering)
- National Chemical Products (chemistry, microbiology and animal nutrition)
- Metal Box Company of South Africa (corrosion mechanisms and microbiology)
- Tellumat (development of electronic instruments)
- Rembrandt Group (development and improvement of tobacco and liquor products)
- South African Pulp and Paper Industries (wood technology, paper manufacturing and water treatment)
- Standard Telephones and Cables South Africa (long-distance transmission of information and lightning protection).

Natural-resource development

South Africa's fluorspar chemicals sector has enormous economic potential. The Department of Science and Technology has implemented a fluoro-chemicals development programme targeting human-capital development, new business formation and novel processes and products. A multipurpose fluorination pilot plant was completed and launched in 2012.

The department secured a commitment of R60 million for the period 2013 to 2015 from the competitiveness fund announced by the Minister of Finance in 2012.

This enabled it to increase the companies on its register by a further 50 companies by the end of 2012/13, with an additional 100 planned by the end of 2014/15.

By May 2012, the department had invested close to R108 million in titanium initiatives. Activities included the commercialisation of a novel process for low-cost production of titan-ium powder. Researchers were able to produce kilogramme quantities of titanium powder.

The next stage – 2 kg/hour production of the powder – is expected to be achieved through the creation of a titanium powder pilot plant at the CSIR in Pretoria. Over the next three years, the department will allocate more than R100 million for the titanium initiative, R50 million, which will come from the economic competitiveness fund.

Human-capital development

The Department of Science and Technology's Human Capital and Science Platforms Subprogramme conceptualises, formulates and implements programmes aimed at developing and renewing science, engineering and technology human capital to promote knowledge generation, protection and exploitation.

Early in 2011, about 272 interns graduated from the Department of Science and Technology and the NRF Internship Programme. Since 2006, almost 750 interns have been hosted by various Department of Science and Technology institutions, including science councils, national facilities and museums. By 2011, R29 million had been invested in the programme, with a further R45 million earmarked for the next three years.

At the sixth Science Centre World Congress in Cape Town in September 2011, the Minister of Science and Technology, Ms Naledi Pandor, announced the establishment of 26 science centres across South Africa. The centres are seen as vital to developing human capital and strengthening the country's science and technology culture.

In September 2011, the South African Young Academy of Science was launched. The academy is intended to facilitate and enhance the participation of young scientists in the mainstream research and development across all disciplines and to provide young scientists with the opportunity to use their knowledge to address South Africa's socio-economic challenges. The SARChI is proving to be an effective instrument for developing human capital. In 2008/9, the department spent R100 million on the SARChI programme; in 2012/13, this rose to R302 million.

In 2011/12, the department fulfilled its target of 62 new chairs: The NRF issued a call for 60 new chairs, while the department's Swiss counterparts agreed to creating two joint South African/Swiss research chairs. By May 2012, there were 152 SARChI chairs. The NRF established an additional 25 postdoctoral fellowships, each worth R180 000 a year, for three years.

International science cooperation can be seen in the growth of the number of internally co-authored publications, particularly after 2004, and of citations, according to Science Watch. Papers co-authored with the USA rose from 1 700 to nearly 5 000 between 1994 and 2008. South Africa is strong in several fields, including Computer Science, Environment/ Ecology, Space Science, Immunology and Clinical Medicine.

In May 2012, Minister Pandor announced a one-year science and technology graduate internship programme in partnership with the Da Vinci Institute and the TT100 companies, to give young graduates work experience and the opportunity to learn entrepreneurship skills from successful technology companies.

The initial intake comprised 50 interns. The department allocated R110 million in the 2012 to 2014 period to the programme, drawing on the R9,5 billion economic competitiveness package announced in the Budget in February 2012. In 2012 and 2013, it allocated R15 million in each year, and R80 million in 2014/15.

In March 2013, the South African National Space Agency (SANSA) and the Russian Federal Space Agency (Roscosmos) signed the Radio-Astron Space Satellite Agreement. Coinciding with Russian President Vladimir Putin's visit to the country to attend the 5th BRICS Summit, the agreement paved the way for the two countries to work together on the development of science and space technologies.

In 2006, the South African and Russian governments signed an agreement to cooperate on the exploration and use of outer space for peaceful purposes.The RadioAstron satellite was launched by Roscosmos on 18 July 2011. It carries a radio telescope that will obtain images and coordinates of various radio-emitting objects.

In 2012, ASSAf made significant strides in increasing access to online journals and the visibility of South African research. The implementation of SciELO (Scientific Electronic Online), South Africa's open-access platform, provided free access to South African scholarly journals. By May 2012, there were 22 journals on the platform, with plans to grow to 180 journals. Statistics showed that the site was visited over 1 000 times a day, with over half the visits from outside Africa. Between May 2009 and May 2012, the South African Journal of Science had nearly 130 000 articles downloaded.

International cooperation

The Department of Science and Technology is not only entrusted with the overall coordination of national research and innovation initiatives in South Africa, but is also responsible for overseeing and facilitating South Africa's international scientific and technological cooperation.

The International Cooperation and Resources Programme of the Department of Science and Technology is tasked with facilitating and nurturing bilateral scientific cooperation with countries in Africa, Europe, the Americas and Asia. The same programme nurtures multilateral scientific cooperation with the African Union, the United Nations system, donor agencies and foundations, global research infrastructure projects, and multinational companies, as well as focused strategic partnerships, such as with the EU.

The department currently has three international offices, located at South Africa's diplomatic missions in Tokyo, Moscow and Brussels, dedicated to promoting cooperation with Japan, the Russian Federation and the EU.

The Department of Science and Technology has also seconded an official to the secretariat of the SADC in Gaborone, Botswana, and has in the past seconded an official to the African Union Commission in Addis Ababa, Ethiopia.

However, the Department of Science and Technology does not have exclusive responsibility for matters related to science diplomacy;

it works closely on matters of mutual interest with its sister departments, such as the Department of Trade and Industry, the Department of Environmental Affairs, and the Department of International Relations and Cooperation and its network of diplomatic missions abroad.

Many of South Africa's national science councils or other public-funded research and technology organisations also have dedicated teams working on international cooperation. These include the NRF, which is responsible for the implementation of international science and technology cooperation agreements.

As with other aspects of government action, the coordination of various engagements, and the activities of these actors, is enabled through various interdepartmental forums and clusters. The science diplomacy agenda, thus, comprises multiple initiatives, but all target strategic national priorities.

The South African science diplomacy agenda comprises and has achieved success in three areas:

- diplomatic efforts to promote international scientific cooperation
- international scientific cooperation to address political and economic developmental goals related to foreign policy
- the science content of topical international relations issues and the diplomatic effort required to deal with them.

African Network on Drugs and Diagnostics Innovation (Andi)

Launched in 2011, Andi is based in Addis Ababa, Ethiopia at the UN offices of the Economic Commission for Africa. Its board agreed that five regional hubs were to be created to support regional research initiatives, with South Africa offering to host the southern hub.

Andi evaluated African research initiatives on drugs and diagnostics, and identified 35 CoEs throughout Africa that were to receive priority attention. Fifteen of these centres are in South Africa.

All the centres are tasked with researching responses to the most intractable health burdens of the continent, from malaria and tuberculosis to river blindness. Many of these are diseases of the poor and invisible; their researchers do not receive funding or intellectual support from established agencies – Andi aim is to reverse this.

It provides support to innovation in quality water provision that is community-led and -based through various agencies. It supported the development and use of new energy-efficient and attractive construction materials through the CSIR-led infrastructure innovation programme – 410 houses were built in Kleinmond, creating an integrated suburb.

It supports rural-based poverty alleviation initiatives in Limpopo, the Eastern Cape and KwaZulu-Natal. Another facet of Andi is the Ketlaphela/Lonza initiative, launched early in 2012. This project aims to build a plant to manufacture active pharmaceutical ingredients for antiretroviral (ARV) production.

The departments of science and technology, trade and industry, economic development and health collaborated on this initiative, which aims to secure a significant proportion of the ARV market for local producers.

In December 2012, governments meeting at the UN Climate Change Conference (COP18) launched a new commitment period under the Kyoto Protocol, as well as agreed on a firm timetable to adopt a universal climate agreement by 2015. They also agreed on a path to encourage response to climate change, endorsed the completion of new institutions and agreed on ways and means to deliver scaled-up climate finance and technology to developing countries.

The Kyoto Protocol, the only existing and binding agreement through which developed countries commit to cutting greenhouse gases, has been amended so that it continued as of 1 January 2013. The length of the second commitment period will be eight years.

Conclusion

South Africa is blessed with rich resources and immense possibilities, and in recent years there has been unprecedented activity in the world of science and technology. But to take full advantage of these opportunities, the

country needs more young people to follow science-based careers. The Department of Science and Technology therefore continues to employ Science and Maths olympiads and competitions to identify and nurture talented young people.

South African universities train more and more scientists each year, with whose help the country will be able to spend R45 billion on research and development by 2014, thus reaching its target for gross expenditure on research and development of 1,5% of gross domestic product.

Over the past decade, research and development expenditure has grown five-fold from R4 billion to R21 billion. There are now some 14 000 scientists, engineers, technologists, technicians, managers and other technical staff directly involved in research and development.

A total of 60 new research chairs were awarded to various institutions of higher learning throughout South Africa during the 2011/12 and 2013/14 MTEF. This increased the number of research chairs in South Africa to 154.

During the past financial year, the TIA has also made great progress in taking stock of all the projects in the institutions it inherited and has been able to identify many marketable products from research that was in incubation.

In addition, the department has strengthened its interaction with business leaders of companies that invest substantially in science and technology.

South Africa has made a commitment to reduce greenhouse gas emissions. The Department of Science and Technology has therefore established research programmes based at various universities, focusing on solar and wind energy, as well as on biofuels. To this end, two new research chairs have been established for biofuel research.

However, the most pioneering work is taking place in the area of hydrogen and fuel cell development, which is potentially the clean fuel of the future. Most hydrogen fuel cells use catalysts made of platinum group metals, which is good news for South Africa as the country has more than 75% of the world's known platinum reserves. This advantage, together with an increased focus on research, places South Africa in a strong position to seize the opportunities offered by a future hydrogen economy.

Food security and access to clean water remain among government's top priorities – the department is therefore also focusing on using science and technology to ensure that existing water supplies are clean and is playing an active role in ensuring food security into the future.

To this end, seven of the 60 new research chairs initiated by the department will serve the areas of rural development, food security and land reform, bringing the total of such chairs to 10.

Acknowledgements

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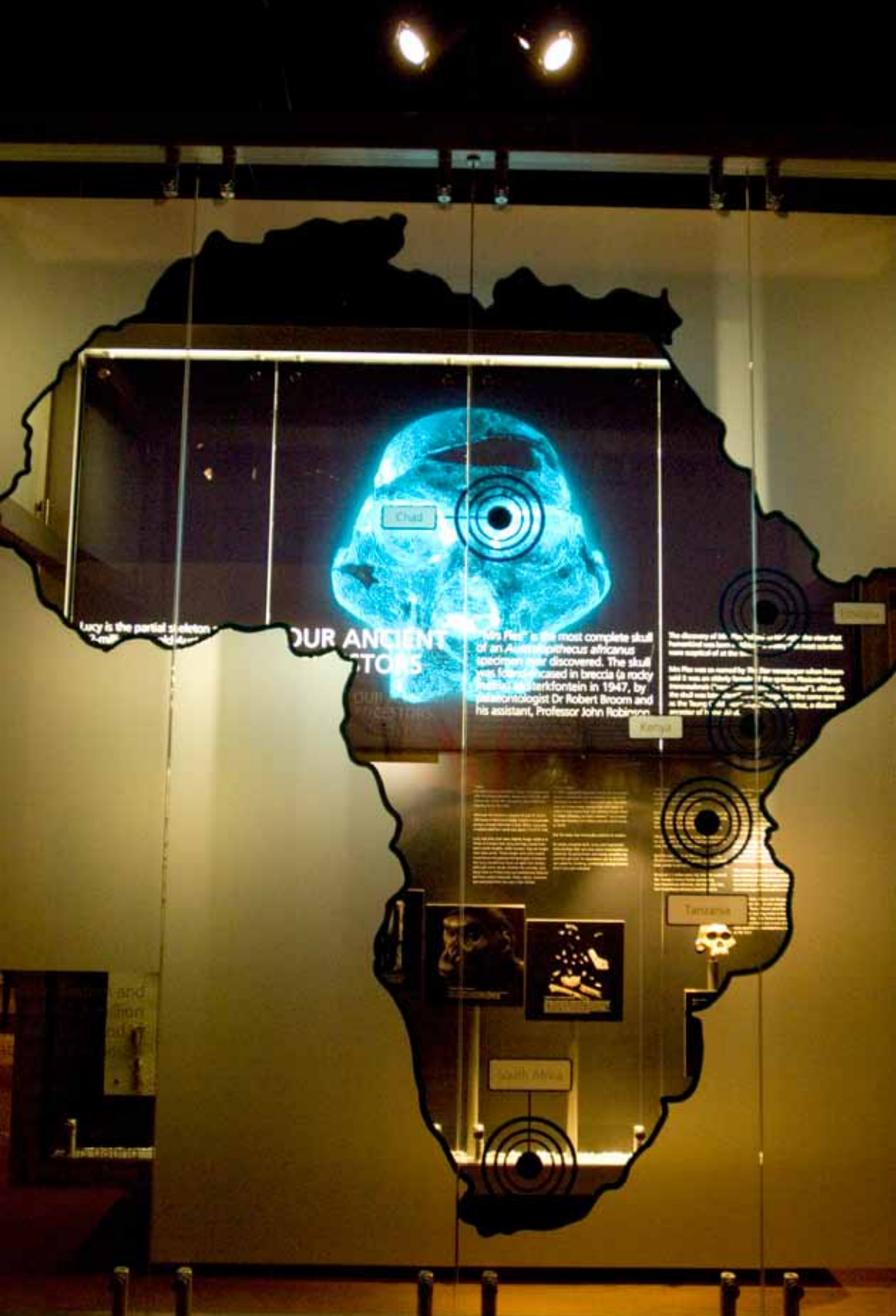
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