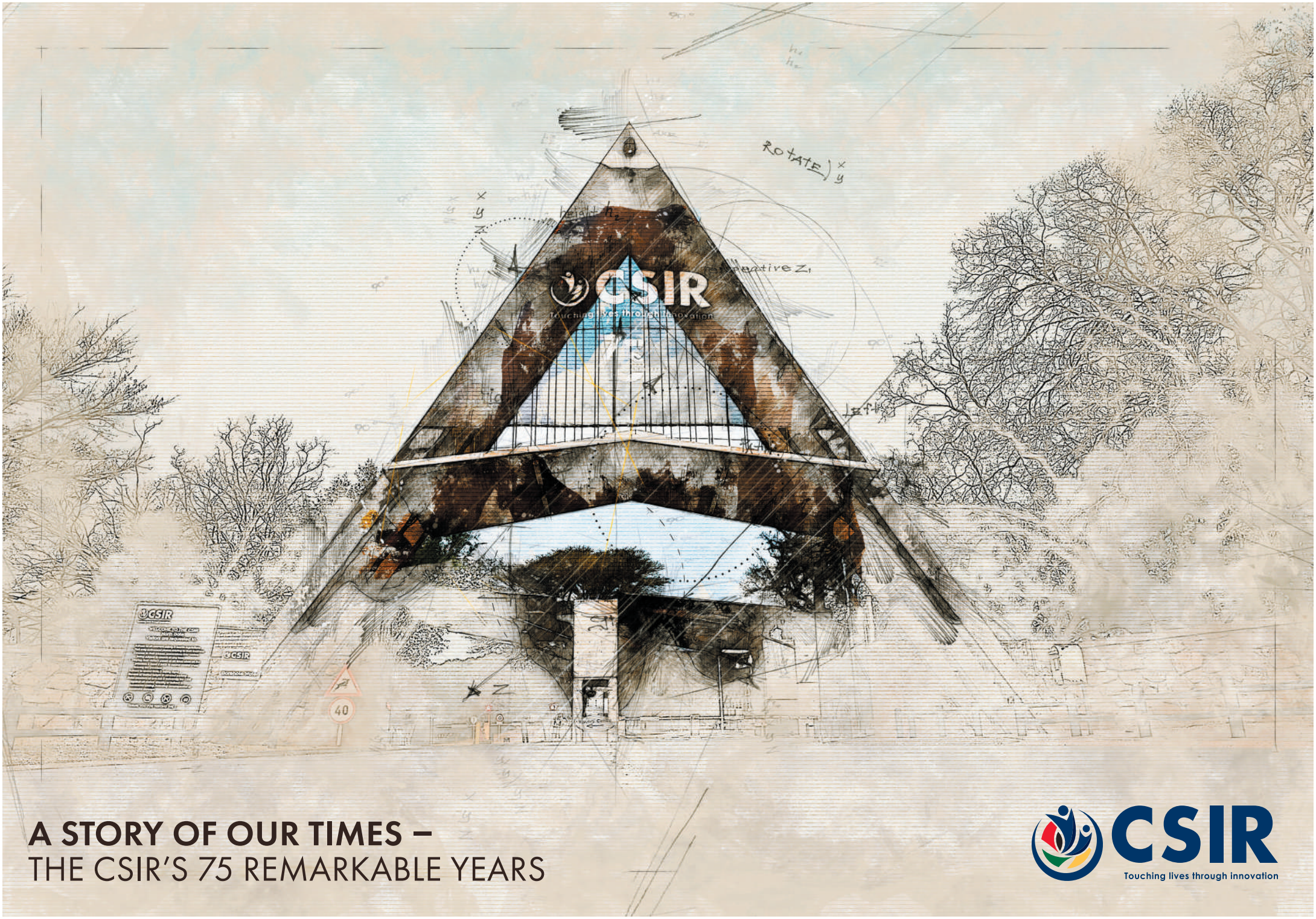

A STORY OF OUR TIMES –
THE CSIR'S 75 REMARKABLE YEARS

CSIR
Touching lives through innovation

science & innovation

Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

75 YEARS ANNIVERSARY

CSIR
Touching lives through innovation

Table of CONTENTS

DEDICATION
– A TRIBUTE TO EXCELLENCE

DR THULANI DLAMINI
CSIR CHIEF EXECUTIVE OFFICER

Success is about being dedicated to journeying with vision and foresight; with grit, ingenuity, resilience and strength; as well as the character, humility and determination that lead, unfailingly, to extraordinary achievements, progress and prosperity.

This book commemorates the men and women of the CSIR whose dedication, drive and determination over the past 75 years endowed South Africa with a rich heritage of research excellence and innovation, and a world-class infrastructure. Since 1945, their passion and commitment have enabled the CSIR to stand proud, stand out and stand firm on a solid foundation of scientific prowess and technological achievement.

We acknowledge and pay tribute to all our CSIR colleagues, past and present, for their contributions to a legacy that makes us proud and one that will continue to touch the lives of all who share our land and our region.

The 21st century has ushered in a revolution that is changing the very essence of science, technology and innovation as we know it. A revolution that will define the next 75 years for the CSIR. We stand ready to embrace the opportunities and explore the full potential of tomorrow's technologies for the future well-being of the CSIR, South Africa and the world.

Dr Thulani Dlamini
CSIR Chief Executive Officer

1995: 50 years

2005: 60 years

2015: 70 years

2020: 75 years

ACKNOWLEDGEMENTS

The publication of this coffee table book was made possible by the CSIR's rich trove of archival material and the contributions, memories, insights and anecdotes of many who forged the footprints and shared the CSIR's remarkable 75-year journey.

We are deeply indebted to the CSIR's past and current presidents and chief executive officers, Dr Chris Garbers, Dr Brian Clark, Dr Geoff Garrett, Dr Sibusiso Sibisi and Dr Thulani Dlamini, for sharing their memories, perspectives and insights of events during their tenures. We greatly appreciate their willingness and the time taken to contribute to this book.

Our heartfelt gratitude goes to Dr Blade Nzimande, Minister of Higher Education, Science and Innovation, and Prof. Thokozani Majozi, CSIR Board Chairperson, for the value of their contributions, which added significant context to the story.

We are also grateful to the staff of CSIR Information Services, specifically Itumeleng Nthite, for their assistance in sourcing the historical material and images that contributed so richly to the contents of the book. Our gratitude also goes to the CSIR Communication team for their contributions and commitment to the project.

We would like to express our thanks to the CSIR Executive, management teams and employees (past and present) without whose enthusiasm and willingness to assist, this story would have been poorer in the telling.

As the editorial team, we take pride alongside our colleagues and all others involved in or associated with the CSIR, in showcasing a small selection of its many achievements over the past 75 years. It is, indeed, a story of our times, one that inspires and emboldens us all to embrace and enjoy the journey that lies ahead.

The Editorial Team

FOREWORD

PROF. THOKOZANI MAJOZI
CSIR BOARD CHAIRPERSON

"Our instinct to face every challenge with vigour, coupled with the resolve to pursue that which we can barely achieve with our utmost efforts, is the mainstay of our survival. The CSIR has faced many challenges during its 75-year history and always emerged stronger and better. We have perfected the art of preparedness at all times and are ready to face the future as we continue to improve the quality of life of the people of this land.

The CSIR celebrated its 75th anniversary on 5 October 2020. The organisation has come a long way from its origins in the aftermath of the Second World War – colleagues from those early years would be amazed by the technological advances and the great strides that the country has made, particularly on issues of democracy and demographic transformation. What has remained the same and still binds us together, however, is the essence of scientific wonder, the very human drive to explore, understand and add meaningful value to the world in which we live.

The journey of the CSIR ensued over four epochs, each with its own identity and character. The first epoch spanned more than four decades, from 1945 to 1988. During that time, the CSIR served the country as a scientific powerhouse with strong research and technological innovation that gave birth to new industries, as articulated in its founding mandate. As these industries emerged, foreign capital flowed into the country. This was indeed the golden age for science, as well as those who practiced science, and the research and development conducted within the CSIR helped to reawaken economic growth.

During the late 1980s, fiscal pressures led to introspection and a need for recalibration. It had become abundantly clear that the CSIR could no longer depend solely on government funding and needed to adopt a business-orientated approach to generating revenue in its own right to survive. This constituted the second epoch in the CSIR's journey and lasted almost two decades, from 1988 to 2006. Most of the work at the CSIR during that period was industry-driven. The bottom-line focus was on income-earning contract research to remain viable as a sustainable business entity. Towards 2005, the contract-driven focus had affected the balance between the scientific research ('S') and industrial development ('I') contributions in the organisation. The realisation that the pendulum had swung too far in the one direction led to a change in course and the CSIR embraced its third epoch, from 2006 to 2018, with a revitalised emphasis on scientific research.

By 2018, however, feedback from the CSIR's partners indicated that the organisation was reneging on its mandated industrial development, which it achieves in two ways – by supporting industry to remain competitive in an increasingly globalised business environment and through the formation of start-ups. In heeding this call, the CSIR adopted a new strategy in 2018. The emphasis of this strategic trajectory is on balancing our scientific research ('S') endeavours with industrial development ('I') to fulfil our mandate. Going forward, the commitment of the CSIR is to explore and use science to drive innovation and create new industries and jobs.

This fourth epoch in the evolution of the CSIR, which started in 2019, was informed mainly by exposure to future scenarios and a determination to build onto our solid 75-year foundation to remain relevant for the next 75 years and beyond.

The CSIR's achievements would not have been possible without the capabilities, commitment and resourceful endeavours of its employees. From the ingenuity of the CSIR team acknowledged as the first in the world to track and predict the re-entry of Sputnik-1, the world's first artificial satellite, into the Earth's atmosphere in 1957, to our current achievements in nanotechnology, additive manufacturing and synthetic biology, it has always been the people who made it happen. We have been very fortunate, over the years, to attract some of the best talent in the country and from around the globe. We believe that the CSIR represents a universe in which the emphasis is on talent and diversity, regardless of background or ethnicity.

Certainly, from a governance perspective, equity is embedded in the structures, systems and processes that direct, control and hold us, as a public entity, to account. Since the dawn of our democracy, a clean audit track record has been testimony to our emphasis on ethical business conduct and performance excellence that is monitored, measured and reported on annually, in accordance with best-practice corporate governance. This ensures that the CSIR leads innovation, accelerates socioeconomic prosperity and acts with independence and within the best interest of the organisation to fulfil its mandate.

Locally, across Africa and globally, the role of the CSIR remains a key driver in the ecosystem of innovation. As our journey continues, we look forward to a future of shared endeavour to increase our knowledge, develop new capabilities and contribute to ground-breaking innovations in service of society and to the benefit of humankind.

Prof. Thokozani Majozi
CSIR Board Chairperson

PREFACE

DR BLADE NZIMANDE

MINISTER OF HIGHER EDUCATION, SCIENCE AND INNOVATION

The year 2020 marked the 75th anniversary of the CSIR, a singular milestone and outstanding feat that finds expression through the celebration and reflection in this commemorative coffee table book. The stories and memories captured on these vibrant and colourful pages give insight into the CSIR's world-class performance and the exceptional accomplishments of ordinary people who achieved the extraordinary.

The timelines that track the CSIR's footprints take us along urban pavements in pursuit of industrial development and into rural communities where technology solutions meet developmental needs. Anecdotes follow those footprints into neighbouring countries and farther away, into countries beyond the borders of our continent. Vignettes reveal tales of exploration, discovery, wonder and wisdom.

Contributions from CSIR past and current presidents are enlightening as they reminisce about the changes, challenges and accomplishments during seven-and-a-half decades of excellence in science and technology. The pages brim with images and narratives that bear testimony to the relevance of the CSIR since its establishment by an Act of Parliament in 1945, and its critical role in our country's ecosystem of innovation.

In collating the storyline for this book, the CSIR was fortunate to have had access to many of those who shared the journey and provided oral and written anecdotes about the feats and footprints of 75 years. Their contributions added richly to the context and detail of this compilation – truly *a story of our times*.

Encapsulated in the story is also the CSIR's ongoing transformation from an instrument of colonial and apartheid oppression and exploitation into a platform for the development of South African society as a whole.

The CSIR's scientific endeavours have always been, and will continue to be, integral to the way we live our lives. With greater knowledge, insight and understanding, we can restore historical disparities, deal with current realities, identify future opportunities and equip ourselves to meet the challenges that lie ahead.

The most demanding target that our country is yet to meet, is the one identified in Vision 2030 of our National Development Plan, which shows that we need to create 11 million jobs in the next 15 years. Science and technology are critical components of ensuring that we meet this and the other goals envisaged in Vision 2030.

The two areas that need our concentrated efforts – investment in science, technology and innovation and the productivity and return from such investment in the fight against the triple challenges of poverty, inequality and unemployment – are where the importance of entities like the CSIR is undisputed and integral to supporting government to build a capable state.

A story of our times – The CSIR's 75 remarkable years is indeed a proud portrait of an organisation that will stand firm as it embarks on the next 75 years.

I look forward to being part of this next epoch and wish the CSIR and its people the very best as they build on a remarkable past to blaze the trail into a dynamically new, very different and digitised future.

Dr Blade Nzimande
Minister of Higher Education, Science and Innovation

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REPUBLIC OF SOUTH AFRICA

PROFILE –
IN PURSUIT OF EXCELLENCE

Through the upheavals of change to the dawn of democracy, one of the constants in the 75-year history of the CSIR has been the value of science and technology in the development of our country and the well-being of current and future generations.

The CSIR is a significant contributor to research and development (R&D) in South Africa's public sector, accounting for about 15% of government's total R&D expenditure or about 4% of that of the country. The organisation contains several unique research facilities and, in many respects, occupies a unique position within the National System of Innovation (NSI). Its national footprint is serving diverse communities and sectors, with the main campus in Pretoria and regional offices in Cape Town, Durban, Johannesburg and Stellenbosch, all in proximity to applicable industries across the country.

An acknowledged leader in scientific research and technological innovation in Africa, the CSIR researches, develops, localises and diffuses technologies to accelerate socioeconomic prosperity in South Africa. Established in 1945 through an Act of Parliament, the organisation's executive authority is vested in the Minister of Higher Education, Science and Innovation.

With national government as its shareholder, the CSIR's directed research is aligned with its mandate to research and innovate, as well as with national priorities and its competencies in science, engineering and technology. At its core, the CSIR's business intent is to create a meaningful and lasting impact on industrial development, as well as economic growth, societal wellbeing and the creation of a capable state.

THE CSIR AT A GLANCE

The staff profile is as at 30 March 2021. Output and impact figures are for the financial year 2020/21.

75 YEAR ANNIVERSARY 1945-2020

GEOGRAPHIC PROFILE	
	CAPE TOWN, DURBAN, JOHANNESBURG, PRETORIA AND STELLENBOSCH

STAFF PROFILE	CSIR TOTAL STAFF BASE	BLACK SOUTH AFRICANS	FEMALE SOUTH AFRICANS	TOTAL SET BASE
	2 143	1 550	952	1 474

FEMALE SOUTH AFRICANS IN SET BASE	EMPLOYEES WITH DISABILITIES	SET BASE WITH MASTER'S	SET BASE WITH PhDs	BLACK SOUTH AFRICANS IN SET BASE
537	59	426	308	980

PROUDLY LEVEL 1 B-BBEE CONTRIBUTOR

OUR IMPACT – OUTPUT AND OUTCOMES	SMMEs SUPPORTED	EXCHANGE PROGRAMMES WITH INDUSTRY	NEW PATENTS	PUBLICATION EQUIVALENTS	TECHNOLOGY DEMONSTRATORS
	96	8	26	407	48

JOINT TECHNOLOGY DEVELOPMENT AGREEMENTS IMPLEMENTED FOR INDUSTRY	REPORTS CONTRIBUTING TO NATIONAL POLICY DEVELOPMENT	STANDARDS DELIVERED OR CONTRIBUTED IN SUPPORT OF THE STATE	PROJECTS IMPLEMENTED TO INCREASE THE CAPABILITY OF THE STATE
25	21	11	44

CSIR STRATEGIC INTENT

CSIR VISION

We are accelerators of socioeconomic prosperity in South Africa through leading innovation

CSIR MISSION

Collaboratively innovating and localising technologies while providing knowledge solutions for the inclusive and sustainable advancement of industry and society

GROWTH

Refers to inclusive and dual growth for the country and the CSIR. The CSIR will use its capabilities in, for example, skilled human capital and infrastructure to assist in growing the economy; but will also grow to become a world-class organisation.

SUSTAINABILITY

Focuses on CSIR-developed technologies that lead to the advancement and sustainability of South African enterprises and the financial sustainability of the organisation in a resource-constrained environment.

IMPACT

Focuses on the commercialisation of our technologies and innovations for industrial development, as well as technology and knowledge transfer that enable a capable state.

RELEVANCE

Addresses the CSIR's role in driving the relevance of innovation in inclusive sustainable industrial development and the creation of a capable state.

"Technology is like education – it enables people to lift themselves out of poverty."

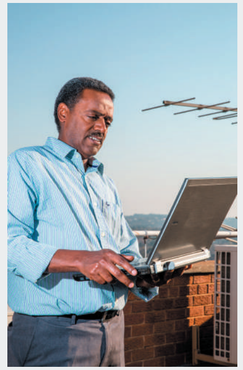
– UNDP Human Development Report, 2006

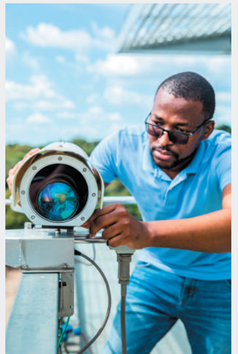
As one of Africa's largest R&D councils, the CSIR has a strong infrastructure base that encompasses specialised facilities, laboratories, virtual platforms and instrumentation for testing, evaluation, design and technology experimentation. This provides a sound foothold from which to collaboratively develop, customise, diffuse and implement technologies that spur competitiveness among high-impact industries and support South Africa's re-industrialisation endeavours.

Internally, the CSIR is committed to transforming human capital, diversifying income and maintaining good governance and financial sustainability. The organisation's investment in a strong core of highly skilled R&D professionals is balanced by nurturing and developing the expertise of its young researchers to grow the national pool of scientists, engineers and technologists. As the next generation, young researchers are transforming the country's science, engineering and technology skills base as role models for students and learners.

The CSIR remains acutely aware of its responsibilities to its shareholder, clients, partners, employees and the communities it serves to help redress the injustices of the past, while being intimately involved in the country's current and future challenges and opportunities.

We share the story of our first 75 years in this commemorative book with pride and humility. We do so as an organisation that acknowledges, and is richer for, the lessons learnt from past challenges and accomplishments. We now embrace the future with a centennial view, a 25-year vision that encompasses the immediate future as a springboard into longer-term time horizons. We can and will, continuously and consistently, strengthen and build our capabilities to journey confidently along the pathways of a new epoch and an entirely different time in history.





"I am confident that this body will become one of the most important organisations of advancement in this country. Science has come forward in gigantic strides and more and more everyone is beginning to realise that scientific research is a matter of vital importance." – Jan Smuts, Prime Minister of the Union of South Africa at the first CSIR Council meeting on 8 October 1945

INTRODUCTION – BUILDING A NATIONAL ICON

"A nation that neglects research is at the same time impairing its prospects of material welfare and weakening its status and dignity among the civilised nations of the world."
– Jan Hendrik Hofmeyr, South African Acting Prime Minister, 1945

Remarkable stories need context. For the CSIR, the rapid expansion of scientific research and development (R&D) in the aftermath of World War II provided the context for its establishment. It was a time when industries expanded; foreign capital flowed and the war-time successes in electronics, radar and instrumentation gave science a new image among publics and governments worldwide. Money and facilities became available at a rate 10-times greater than ever before.

In South Africa, an Act of Parliament in 1945 changed forever the scale and scope of the country's R&D and its standing in a world newly awakened to the importance of scientific endeavour. Envisioned by then Prime Minister Jan Smuts and spearheaded by Sir Basil Schonland, both distinguished scientists, the promulgation of the Scientific Research Council Act in 1945 (Act 33 of 1945) established the CSIR as the country's first major science council and the cornerstone from which our story unfolds.

Located in a scenic garden setting at the southern-most tip of Africa, where, to this day, small buck still roam, the CSIR brought together a group of brilliant scientists, engineers and technologists committed to fulfilling an aspirational mandate of serving the nation through R&D. Schonland's prominence globally in radar research afforded the organisation a leading role in the peacetime application of radar, as well as electronic measurement, testing and evaluation.

During his tenure, from 1945 to 1950, Schonland embedded five pillars as a bedrock for research at the CSIR: laboratories for physics and chemical research and research institutes for building, timber and telecommunications. The organisation prioritised pure and applied scientific research to develop natural resources and industries; coordinated research nationwide; and fostered and trained researchers and technicians. Schonland's eye was on collaborating with universities to spur industrial research and, during his presidency, nearly 160 applied research projects were delivered to industry. He also identified the need for scientific and technical cooperation in Africa to address continent-specific challenges.

Yet, all was not always plain sailing. In 1950, the CSIR's direct line of report to the Office of the Prime Minister changed to the Ministry of Economic Affairs. This lessened the appreciation of the need to invest in scientific endeavours. Schonland's impassioned advocacy at the time for Parliament to recognise the critical role of R&D in the economy came to fruition only decades later with the creation of the Department of Arts, Culture, Science and Technology in 1994 and the Department of Science and Technology in 2002 (recently renamed the Department of Science and Innovation).

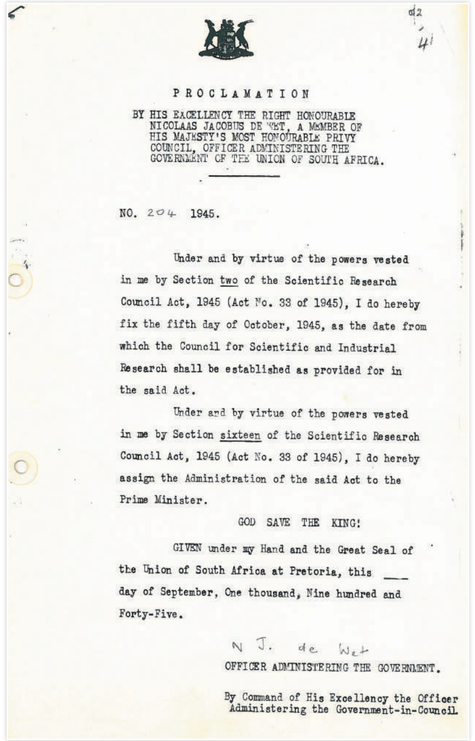
In 1950, Dr Petrus du Toit (1950 to 1952) took up the baton as CSIR President and established the SA Wool Textile Research Institute and a Bituminous Binder Research Unit. These developments testified to the rapid growth and expansion of the CSIR. Growth continued during the tenure of his successor, Dr Stefan Meiring Naudé (1952 to 1971), with an increase in the staff complement from 685 to over 4 000. Additional research institutes in nutrition, mechanical and electrical engineering and defence took shape at the CSIR site in Pretoria, and the first executive team was formed to oversee and monitor the organisation's research activities.

Prior to Naudé's CSIR presidency, while director of the National Physics Laboratory, he secured a 100-hectare site for the CSIR as a gift from the University of Pretoria. Located on the eastern side of Pretoria, Naudé guided the layout and development of the site to retain as much of the natural environment as possible between buildings. This gave gestalt to Schonland's conviction that the ambiance of a natural, garden-like environment would nurture and stimulate brilliant minds to produce exceptional science.

In the 1950s and 1960s, the CSIR attracted many of the world's talented minds in science who wanted to escape from countries devastated by WWII and start afresh in South Africa. It was a time of observing, learning, understanding, collaborating and partnering in a collective effort to apply new knowledge and scientific solutions to the challenges of a post-war society. This contributed to the CSIR's growing reputation for R&D leadership locally, with almost 80% of all chemical research in the country located at the site in Pretoria. The organisation's chemical research endeavours often won international acclaim.

Yet, no organisation develops in isolation. For the CSIR, interaction with peers, partners and collaborators in government, academia and the private sector, as well as 14 countries in Africa, also shaped the organisation to respond more effectively to industry and socioeconomic needs.

The 1970s brought their own challenges. Due mainly to fiscal pressures, but often also a desire for more direct control over applied research activities, governments worldwide started questioning the real value of science and technology and its perceived failure to solve the challenges of developing nations.



PROCLAMATION

BY HIS EXCELLENCY THE RIGHT HONOURABLE NICOLAAS JACOBUS DE WET, A MEMBER OF HIS MAJESTY'S MOST HONOURABLE PRIVY COUNCIL, OFFICER ADMINISTERING THE GOVERNMENT OF THE UNION OF SOUTH AFRICA.

NO. 204 1945.

Under and by virtue of the powers vested in me by Section two of the Scientific Research Council Act, 1945 (Act No. 33 of 1945), I do hereby fix the fifth day of October, 1945, as the date from which the Council for Scientific and Industrial Research shall be established as provided for in the said Act.

Under and by virtue of the powers vested in me by Section sixteen of the Scientific Research Council Act, 1945 (Act No. 33 of 1945), I do hereby assign the Administration of the said Act to the Prime Minister.

GOD SAVE THE KING!

GIVEN under my Hand and the Great Seal of the Union of South Africa at Pretoria, this ___ day of September, One thousand, Nine hundred and Forty-Five.

N. J. de Wet
OFFICER ADMINISTERING THE GOVERNMENT.

By Command of His Excellency the Officer Administering the Government-in-Council.

[Sea change (noun) 'si: tʃeɪndʒ/: strong, clear and definite change in a situation; big change in perspective; to undergo a complete transformation]

The CSIR was not exempt from such scrutiny but the organisation had, at the time, already embarked on a trajectory towards greater autonomy and less dependency on shareholder funding. This was rewarded with a steady increase in contract income while sustaining its involvement in R&D to support national priorities.

In 1971, Dr Chris van der Merwe Brink, at the helm until 1980, succeeded Naudé and strove to coordinate research between the CSIR, industry and universities, with an emphasis on applied research. The intent was to affirm the benefits and relevance of science and technology to all sectors of society. At the time, the CSIR's satellite tracking collaboration with CNES (French National Centre for Space Studies) and NASA (American space agency), for instance, raised the organisation's international stature significantly, while the Satellite Remote Sensing Centre (later renamed the CSIR Satellite Applications Centre) became one of the busiest satellite tracking stations in the world.

Still on Brink's watch in 1977, the CSIR Conference Centre, later renamed the CSIR International Convention Centre (ICC), opened its doors to a wide range of local and international events that attracted participants from across the globe. To this day, the centre remains one of the premier, award-winning conference centres in South Africa.

The 1980s heralded the first sea change for the CSIR. The process started during the presidency of acclaimed scientist and visionary, Dr Chris Garbers, who succeeded Brink. His tenure, from 1980 to 1990, was characterised by changing circumstances at national level and within the organisation. The global economy was in recession, the country was experiencing persistent inflation and severe drought, and the national research laboratories were under pressure to respond to immediate technological needs.

Under his leadership, the CSIR's overseas offices continued to foster mutually beneficial bilateral research agreements. In the mid-1980s, the organisation's shift from its R&D focus to applied research and technology transfer to meet industry needs was underscored by the 1983 Kleu Report and the 1985 White Paper on Industrial Development Strategy. The CSIR also formulated its equal opportunities policy during that time.

Garbers also strongly supported the brand change in the 1980s to better represent the CSIR's change in R&D focus. The triangle of the CSIR's A-frame gateway, captured in the old logo, changed to four equilateral triangles that symbolised the interaction between the basic sciences and their contribution to the multidisciplinary problem-solving capabilities of the CSIR. The intention with the new logo was also to bridge the silo-mentality in the organisation at the time and unite research efforts, while Garbers encouraged researchers to interact with peers at a global level. This included participation in ICSU (non-governmental body for international scientific cooperation) activities and international peer reviews, as well as an exchange programme for researchers between the CSIR and China's National Science Council.

The CSIR reached its 40-year milestone in 1985 with an accumulation of scientific knowledge and business acumen that helped it to remain financially viable. During those first 40 years, bursaries had been made available for postgraduate study in science and engineering, while the CSIR's operational units undertook 2 500 R&D contracts on behalf of industry.

In response to the 1985 White Paper on Industrial Development Strategy, a robust management review confirmed the two major functions that would take the organisation forward: a technology partner to public and private sector clients and a sponsor of human capital and research development in science and engineering, primarily at tertiary level in institutions across the country.

Formidable challenges during the 1990s tested the CSIR's resilience as the country's principal technology provider and a major link to the international scientific research community.

With Garbers' hand on the tiller, evidence abounded of the CSIR's significant contributions to South Africa's university, medical and industrial R&D, which included its support to enterprises, establishing specialised research councils and successful start-up companies, and enhancing the scientific and technological capacities of major players, such as Denel Aerostructures.

The CSIR had also been registering patents since the early 1950s, but only in the mid-1980s did Technifin, a venture capital company, take form to manage investments in innovative technologies in collaboration with the Industrial Development Corporation. Typically, only three to five of approximately 2 000 patent applications received annually by the mid-1990s had international potential. The CSIR's technology for lithium-ion batteries certainly ranked as one of the most important among them.

The winds of change continued throughout the Garbers presidency and resulted in a fundamental restructuring of the CSIR in April 1988. The amended Scientific Research Council Act, 1998 (Act 46 of 1988), determined that the organisation would be known by its acronym only and separated the offices of chairperson and chief executive. Dr Louw Alberts, a man of science committed to reconciliation and justice, became the first independent chairperson of the new CSIR in 1988.

For Dr Brian Clark, who succeeded Garbers as CSIR President in 1990, as the eighth CSIR President in a post he held until 1995, the challenges were significant. Stakeholder expectations ranged from government that regarded the CSIR as its scientific arm, to industry that clamoured for technology transfer. European and American clients also held back with concerns about the state of the CSIR's technology after its long isolation.

Clark's leadership changed the management style in the organisation. The emphasis was on results-driven performance, team work and deliverables that were aligned with internationally benchmarked business principles.

Efforts at the time to rid the CSIR of its bureaucracy were given a boost when then Minister of National Education F W de Klerk (later South Africa's State President from 1989 to 1994 and Deputy President from 1994 to 1996), facilitated the introduction of framework autonomy. This enabled the CSIR to align its change in course with the global shift in R&D, which emphasised implementation.

In 1990, the Foundation for Research Development, now the National Research Foundation, became independent of the CSIR. Shortly thereafter, in 1991, a study commissioned by the African National Congress, the Congress of South African Trade Unions and the South African National Civics Organisation to determine an appropriate science and technology policy for South Africa, described the CSIR as a "very significant South African investment in scientific research" with "modern facilities and a tradition of technical competence".

In 1990, the release of Dr Nelson Mandela, who became South Africa's first democratically elected President in 1994, saw the start of South Africa's slow, but determined, redressing of apartheid ills. At the CSIR, the conscious move from fundamental to applied research was paying dividends with a Technology Top 100 Award in 1991 and the South African Foreign Trade Organisation Business Development Award in 1992.

The organisation's transformation enabled it to support large industries to compete internationally, while its multidisciplinary capability could tackle national challenges in sectors such as the natural environment, automotive and mining. Today, this multidisciplinary nature of the organisation remains one of its biggest assets.

With democracy progressing, the CSIR would be challenged even further. A second major transformation started in 1993/94. Under the leadership of Dr Geoff Garrett (1995 to 2000), who succeeded Clark in 1995, the organisation extended its focus on relevant research to responding to technological needs for continued development, job creation and a sustainable environment.

Globally, the CSIR established cooperation agreements with international research institutions and participated in intergovernmental agreements. As the regional focal point for Africa, appointed by the World Association of Industrial and Technological Research Organizations, the CSIR

"The CSIR's approach of looking at challenges from a systems or whole-environment point of view means that it can draw successfully from its multidisciplinary base to deliver a holistic solution as opposed to addressing only symptoms."
– Derek Hanekom, Minister of Science and Technology, 2013

further strengthened its role on the continent. At home, the research landscape was also changing to reflect, as in other sectors, a science, engineering and technology base representative of the diversity of the country's population.

Dr Sibusiso Sibisi (2002 to 2016), a mathematician and former chairperson of the National Advisory Council on Innovation, took office in January 2002 as President and CEO of the CSIR (the designation of 'President' in science councils has since been replaced by that of CEO).

Under his leadership, as the third President to guide the organisation's transformation, reconfiguration and repositioning, the CSIR prioritised relevant, knowledge-generating research and building and transforming human capital to strengthen its science and technology base. A new corporate identity debuted at the first CSIR Biennial Conference in February 2006.

In 2011, Sibisi emphasised growth and impact in response to review panel findings that the organisation was spread too thinly and would benefit from a sharper focus. In refining its focus, however, numerous factors had to be considered to remain relevant: the international development priorities of the Millennium Development Goals and the country's development priorities in the National Development Plan 2030, as well as the organisation's competences, capacity and capabilities.

The renewed focus honed in on the natural environment, defence and security, industry, energy, health, the built environment and enabling technologies such as information and communications technology, nanotechnology and photonics.

South Africa's triple challenge of unemployment, inequality and poverty, as well as regional and international opportunities to collaborate, and a changing global landscape influenced by socio-political events and economic uncertainties, left no room for complacency. Technology transfer remained a priority. The critical role of the CSIR was affirmed, in 2009, by a World Intellectual Property Organization Report that featured the organisation as the top institution by patent cooperation treaty and patent application with a South African priority, as well as revenues generated through commercialisation and the number of start-up companies established.

And still the winds of change held sway. A new strategy for the CSIR took shape under the leadership of Dr Thulani Dlamini, who succeeded Sibisi at the start of 2017. In 2019, the strategy – with its focus on ensuring that the CSIR makes a greater impact in industry, in addition to the role of supporting a capable state – was finalised and endorsed by Science and Technology Minister Mmamoloko Kubayi-Ngubane, setting the organisation on a new trajectory.

Set against a backdrop of declining growth in some of the country's traditionally strong industries, the CSIR took a critical look at how to optimise its contribution to industrial development in South Africa. While still committed to using its capabilities in multidisciplinary research and technological innovation to foster both scientific and industrial development, it had to balance the impact in industry, government and society. The emphasis would be on growth, sustainability, impact and relevance.

Growth means that the CSIR will use its capabilities to inclusively grow the economy, while sustainability refers to developing technologies that improve competitiveness and financial sustainability for the organisation in a resource-constrained environment. Impact focuses on technology commercialisation for industrial development and technology and knowledge transfer that enable a capable state. And relevance addresses innovation as a key driver for industrial development and fulfilling the CSIR's mandate.

On the human capital front, Schonland's emphasis in 1945 on the benefit of an environmentally pleasing workplace still rang true, although significantly bolstered by modern-day infrastructure and best-in-class business practices. At the time of writing this book, these factors had certainly contributed to the CSIR's achievement of Top Employer status based on independent research and international benchmarking of employee conditions of work.

Reflecting on the evolution of the CSIR through 75 eventful years, during which scientific disciplines grew and withered, technologies developed at a dynamic pace and people joined, contributed and left, it is clear that change was the one dependable constant. There is no doubt that it will remain constant and dependable in the years ahead. From our vantage point today, we are convinced that our successors, true to form, will adapt, adopt and innovate to deal with the challenges of change effectively. In turn, the CSIR will continue to fulfil its mandate of applying the products of science and technology to the wellbeing of humankind.

And so, in having commemorated its diamond jubilee on 5 October 2020, a veritable coming of age at 75, the CSIR had a right-of-pride in its accomplishments. Its footprints have trod deeply through the country's R&D landscape and its achievements bear testimony to a journey well-travelled, challenges well-met and achievements well-deserved. Former Minister of Science and Technology Dr Naledi Pandor articulated the essence of its rites of passage through what is truly a story of our times when she said: *"Organisations like the CSIR must consciously marshal the evidence to demonstrate, in a compelling manner, that investments in research and innovation do, and will continue to lead to greater prosperity, more jobs and more entrepreneurs."*

This is the intention of the CSIR's pursuit of its centennial vision towards the dynamically different science scape that beckons.

Right: The CSIR's ability to remain at the forefront of rapid technological change in fields such as laser technology continues to unlock a myriad of cutting-edge applications.

IN CONVERSATION –
LEADERS IN RESPECT, RELEVANCE AND REPUTATION

"It is better to lead from behind and put others in front, especially when you celebrate victory when nice things occur. You take the front line when there is danger. Then people will appreciate your leadership."
– Dr Nelson Mandela, President of South Africa from 1994 to 1999

Leaders determine the character of an organisation. Leaders raise the bar continuously on performance to create relevance, respect and reputation. The character and culture of the CSIR have always been influenced by the moral compass, conviction and personality traits of its leaders. *Cometh the time, cometh the man* has held true since the CSIR's establishment in 1945. At the time of its diamond jubilee in 2020, nine Presidents had taken up the baton to fulfil this critically important role. From the dynamic and strong-willed Dr (later Sir) Basil Schonland, CSIR founder and first president, and the innate humility and sense of humour of his successor, acclaimed scientist Dr Petrus du Toit, to the drive and energy of *Mr Science*, renowned physicist Dr Meiring Naudé and the people-orientation and pragmatism of Dr Chris van der Merwe Brink, the first four incumbents set the tone that steered the course towards scientific excellence.

In their footsteps followed the five *Captains of Technology* whose hands held steadfast on the tiller of radical transformation since the 1980s. From the analytical acumen and visionary insights of the internationally respected scientist, Dr Chris Garbers, and the performance-driven and decisive leadership of Dr Brian Clark, to the high-energy, competitive, people-orientated and quality-driven Dr Geoff Garrett, the empowering management style and scientific acumen of Dr Sibusiso Sibisi and the strategic leadership and firm resolve to contribute to the country's industrial competitiveness of the current Chief Executive Officer, Dr Thulani Dlamini, the CSIR's leaders have shown exceptional commitment to shaping a better, knowledge-driven future for the people of South Africa and those elsewhere on the continent.

Contributions to this section provide mindful insights and interesting anecdotes about the challenges and achievements from 1980 to the dawn of democracy in 1994 and the journey thereafter until the CSIR's 75-year milestone commemoration in October 2020.

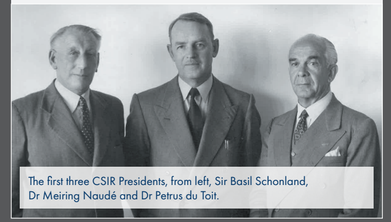
"Going forward, our focus is on further embedding a culture of scientific excellence and innovation to pursue opportunities for growth, industrial development and service delivery with sound science." – Dr Thulani Dlamini, CSIR Chief Executive Officer

SIR BASIL SCHONLAND
1896-1972
DYNAMIC LEADER, INTERNATIONAL REPUTATION IN RADAR TECHNOLOGY

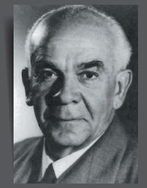
1945-1950

- BA (Hons), Rhodes University
- PhD (Natural Sciences), Cambridge, United Kingdom
- CSIR Founding President
- Chairman, first CSIR Council
- Director, Bernard Price Institute
- Director, Atomic Energy Research, United Kingdom
- Chancellor, Rhodes University
- Knighted 1960, United Kingdom
- Fellow, Royal Society of SA
- Fellow, Royal Society of London, United Kingdom
- WWI OBE (Mil), WWII CBE (Mil)
- *Financial Mail* Scientist of the Century (2000)
- SA Order of Mapungubwe (Gold) (2002)

Dynamic, believed that only one person can be in charge, unperturbed if firm action made him unpopular



The first three CSIR Presidents, from left, Sir Basil Schonland, Dr Meiring Naudé and Dr Petrus du Toit.



DR PETRUS DU TOIT
1888-1967
GLOBALLY RESPECTED, ACCLAIMED SCIENTIST

1950-1952

- PhD (Zoology), University of Zürich, Switzerland
- DrVetMed, University of Berlin, Germany
- Director, Veterinary Research Institute, Onderstepoort, Pretoria
- CSIR President
- Member, first CSIR council
- Adviser, CSIR President
- Chairman, Scientific Council for Africa South of the Sahara
- Fellow, Royal Society of London, United Kingdom

Aloof of politics, humble and fair, keen sense of humour, sought-after speaker, highly respected scientist in local and international science circles

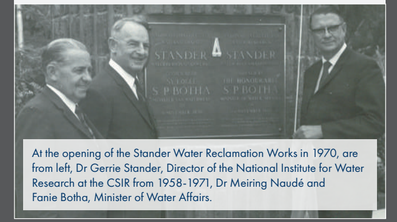
The CSIR Board of 1953/54. Seated from left are Dr P J du Toit, Dr E Taberner, Dr F J de Villiers, Dr S M Naudé, J E Worsdale, Dr B F J Schonland. Standing, from left, E W Dohse, Prof. E T Stegmann, J R Sorrie; P E Rousseau and Prof. H O Mönnig.

DR MEIRING NAUDÉ
1904-1985
RENOWNED PHYSICIST, MR SCIENCE SOUTH AFRICA

1952-1971

- MSc (Physics), Stellenbosch University
- PhD, University of Berlin, Germany (studied under Nobel Laureates Einstein, Von Laue, Planck, Nernst)
- Professor (Experimental Physics), Stellenbosch University
- Director, CSIR National Physics Research Laboratory
- Scientific adviser to Prime Minister
- CSIR Chief Executive Officer and President
- SA Decoration for Meritorious Service (1982)

Driven and energetic, empowering leader, modern approach to government-funded, balanced basic and applied research



At the opening of the Stander Water Reclamation Works in 1970, are from left, Dr Gerrie Stander, Director of the National Institute for Water Research at the CSIR from 1958-1971, Dr Meiring Naudé and Fanie Botha, Minister of Water Affairs.

DR CHRIS VAN DER MERWE BRINK

1915-1980

PRAGMATIC LEADER, 'A HEARTY FELLOW'

1971-1980

- DSc, University of Pretoria
- Professor (Organic Chemistry), University of the Orange Free State
- CSIR Vice-President, Deputy President and President
- SA Decoration for Meritorious Service (1980)

Extroverted, strong leader, phenomenal memory for names and faces, people-oriented, emphasis on applied research

Dr Chris Brink receives a vehicle from R W Curtis of General Motors. The vehicle was converted into a mobile laboratory for air pollution research.

DR CHRIS GARBERS

BORN 1929

BRILLIANT SCHOLAR, VISIONARY

1980-1990

- DPhil (with distinction), University of Zürich, Switzerland (studied under Nobel Laureate Paul Karrer)
- Professor (Organic Chemistry), University of Stellenbosch
- CSIR Vice-President, Deputy President and President
- Chaired the Foundation for Research Development, Scientific Advisory Council and Certification Council, Technikon Education
- State President's Order of Meritorious Service (Class 1) Gold (1989)
- South African Association for the Advancement of Science South Africa Medal (1990)

Global perspective and analytical acumen, relentless quest for optimising results, strong inner compass, courage and conviction to overcome challenges

Dr Chris Garbers in 1988, when a new CSIR logo was introduced after significant organisational change.

DR BRIAN CLARK

BORN 1949

STRATEGIC THINKER, DECISIVE CHANGE AGENT

1990-1995

- DSc, University of Pretoria
- Postdoctoral studies, University of Munich, Germany (Alexander von Humbolt Fellowship) and MRL research grant, Pennsylvania State University, United States of America
- CSIR Director, Vice-President and President
- Fellow, Royal Society of Southern Africa
- Foreign Member, Royal Swedish Academy of Engineering Sciences, Sweden

Drive to achieve, courage to pursue a vision against opposition, strategic thinker, modern management approach, charismatic and empowering leader

Dr Brian Clark receives the Technology Top 100 Award for 1991 from Derek Keys, Minister of Trade and Industry.

DR GEOFF GARRETT

BORN 1948

'CARPE DIEM' TEAM PLAYER

1995-2000

- PhD, Cambridge University, United Kingdom
- Professor and Head of the Department of Metallurgy, University of the Witwatersrand
- CSIR Director, Executive Vice-President: Operations and President
- Fellow, SA Region of International Institutions of Metallurgists
- Fellow, SA Institute of Mining and Metallurgy

Excellent speaker, passion for winning, goal-directed, high standards, quality-driven, approachable people person, recognition where due, maxim: "All business is people business."

Dr Geoff Garrett in 1999, when the CSIR was named the overall winner of South Africa's Corporate Governance Award.

DR SIBUSISO SIBISI

BORN 1955

EMPOWERING LEADER, SCIENTIFIC ACUMEN, CSIR MANDATE AS THE COMPASS

2002-2016

- PhD, Cambridge University, United Kingdom
- Co-Founder, Massive Inference Techniques Ltd and iThemba Pharmaceuticals (Pty) Ltd
- Deputy Vice-Chancellor, University of Cape Town
- Chaired National Advisory Council on Innovation
- CSIR President and Chief Executive Officer
- Fulbright Fellowship, California Institute of Technology, United States of America
- SA Order of Mapungubwe (Silver) (2007)

Pursues scientific renewal, a passion for detail, willing to make big decisions

Dr Sibusiso Sibisi during a photo shoot for *brainstorm* magazine at the global traveling exhibition, *Da Vinci – the Genius* in 2014.

DR THULANI DLAMINI

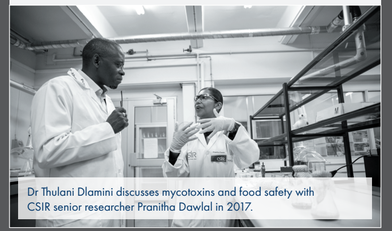
BORN 1970

PEOPLE-CENTRED COLLABORATOR, IMPACT-DRIVEN LEADER

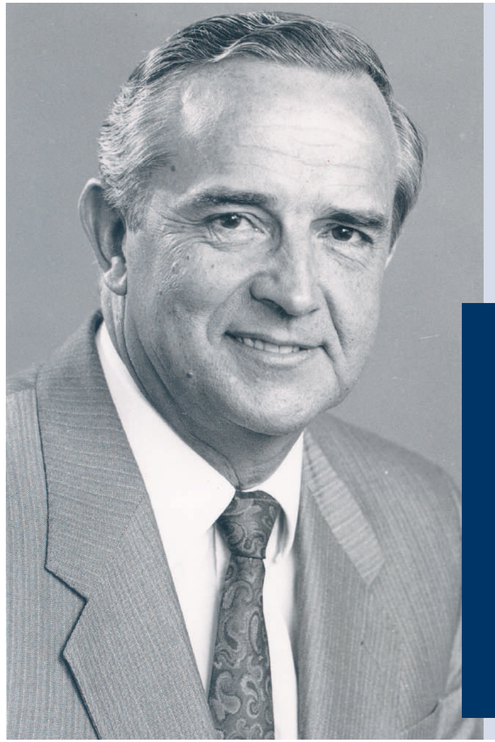
2017 TO DATE

- PhD, University of the Witwatersrand
- Master of Business Leadership, University of South Africa
- Executive Manager: Research and Development, Sasol
- Vice-President: Strategic Research and Technology, Sasol
- CSIR Group Executive: Research and Development and Chief Executive Officer
- Patents (5) in Fischer-Tropsch Technology
- Served on Presidential Commission on the Fourth Industrial Revolution, National Advisory Council on Innovation
- Member, Institute of Directors, SA and Academy of Science of South Africa

Passionate about commercialisation and impact, pursues excellence, committed to transparent leadership



Dr Thulani Dlamini discusses mycotoxins and food safety with CSIR senior researcher Pranitha Dawlal in 2017.



Dr Chris Garbers

CSIR President
1980-1990

"On 2 February 1990, I had a television installed in my office to witness the F W de Klerk speech in Parliament. I was quite emotional, realising that, finally, real change was in the air! Emerging from the massive team effort to change one institution, I realised the immensity of the task ahead to turn a country around."

My association with the CSIR spanned 36 years! I enrolled at the University of Pretoria in 1946 and graduated with a BSc cum laude (majoring in chemistry and mathematics) and subsequently MSc cum laude in chemistry. The University of Pretoria awarded me a Union Scholarship for overseas study. I joined the research group of Nobel Laureate Paul Karrer at Zürich University in Switzerland, from which I emerged as a DPhil cum laude in 1954.

Back home, I joined the young CSIR, at the time located in a well-equipped old munitions factory in Visagie Street, Pretoria at a salary of £53 (R106) per month.

Four years later I joined the University of Stellenbosch, where I initiated research in organic chemistry with equipment support from the CSIR and access to its advanced instrumentation. Under my directorship, the research culminated in a joint CSIR/University of Stellenbosch Research Unit for polyene chemistry.

Towards the end of 1978, Dr Chris van der Merwe Brink, then President of the CSIR, approached me regarding a Vice-President vacancy with responsibility, *inter alia*, for university research grants. Acceptance meant leaving a well-equipped research department, foregoing the pleasure of research and working with enquiring young minds.

I decided to make a clean break and devote myself to facilitating the research careers of the upcoming science and engineering generation. I was promoted to Deputy President in 1980 and, after the unexpected death of Dr Brink in the same year, became President of the CSIR. In 1981, Dr Rein Arndt joined the CSIR Executive as my successor as Vice-President with the responsibility for university research grants.

▶ ***What were some highlights and key challenges during your term as President?***

The key challenge was managing change. World War II clearly illustrated the power of science through epoch-making discoveries, with the promise of a technology-driven future. By the 1970s and '80s, however, there was increasing disillusionment in science and technology and reviews of scientific institutions, with an emphasis on relevance, became a worldwide phenomenon.

South Africa was no exception. It was facing its deepest recession since World War II, with galloping inflation, peaking at 18.65% in 1986! The need to grow the economy became all important. Internationally, South Africa was faced with growing isolation, sanctions, divestment and alienation. Internally, the liberation struggle gained momentum, accentuated by the Soweto uprising in 1976.

Between 1979 and 1983, several reports were published with the Riekert Report (1979), Wiehahn Report (1982) and Kleu Report (1983) of particular significance to the CSIR. In January 1983, the CSIR also commissioned Prof. J S de Wet to undertake a study into research funding for natural and engineering sciences, specifically at South African universities. In response to a number of substantial budget cuts, the CSIR decided against a policy of "equal misery to all". Instead, detailed studies were commissioned on which activities to close, phase out, scale down, maintain, strengthen, initiate or transfer to other organisations. Funds saved by closing down activities were reserved for retraining staff or management training.

The Kleu Report, with its emphasis on resource development, job creation, import replacement and export promotion, prompted the publication of a *White Paper on Industrial Development Strategy in the RSA* in 1985. It identified the CSIR as the organisation that should take the lead in ensuring the effective transfer of technology to industry. Great challenges were outlined, which the CSIR accepted. In June 1985, the CSIR Council approved a management review, to be carried out in cooperation with outside consultants.

Building on the changes that had taken place from 1980 to 1985, the CSIR published the results of an in-depth study in the 1986 document, *Strategy for the Future*. Dr Brian Clark joined the CSIR Executive in 1986 and was tasked to drive technology transfer to industry. On 1 April 1988, a new, restructured, market-orientated CSIR came into being. This led to the creation of two operational arms, namely the Group: Foundation for Research Development (FRD) and the Group: Research, Development and Implementation (RDI) with finance, management services and human resources support groups.

During the restructuring process, activities were closed down, the National Institute for Personnel Research transferred to the Human Sciences Research Council and some services were privatised. The offices of the Chairperson of the Council and Chief Executive (President), previously vested in one person, were separated.

Investigations aimed at finding the most effective way to manage both these functional activities within a single organisation continued. On 13 October 1988, the CSIR Council resolved to recommend to Cabinet that the FRD be hived off from the CSIR as an independent statutory council and in December 1989, Cabinet approved this recommendation. The Research Development Act, (Act 75 of 1990), was approved on 29 June 1990 and the necessary amendments made to the Scientific Research Council Act, (Act 46 of 1988). I retired on 30 September 1990 and, on 1 October, Dr Rein Arndt took over the reins at the FRD as a new statutory council, while the responsibility for the CSIR, now without the FRD, rested on the shoulders of Dr Brian Clark.

The FRD moved into a new building at Scientia and that portion of Scientia was transferred to the FRD, free of charge, on 1 October 1990. In 1998, the FRD incorporated the Centre for Science Development of the Human Sciences Research Council to become the National Research Foundation (NRF).

A major outcome of the restructuring was obtaining greater autonomy for the CSIR to administer its budget according to its own priorities. I believe our strong opposition to the encroachment of civil service bureaucracy on the management of the CSIR eventually resulted

in being granted so-called framework autonomy. A significant improvement that was also extended to other research councils.

▶ *What were the CSIR's major contributions to national priorities and science and technology during your tenure?*

There were many. Let me select a few examples – among new and upgraded facilities, the following deserve mention:

- Commissioning a 1 500 ton cable testing machine as the largest in the country with the highest workload in the world. Testing some 5 000 new and used cables a year, it served the 125 mines registered with the Department of Mineral and Energy Affairs at the time.
- Completing a R35 million upgrade at the CSIR Satellite Applications Centre to process and disseminate data from Earth observation satellites for use in meteorology, agriculture, oceanology, mineral exploration, regional planning and other disciplines.
- Inaugurating the South African Technology Information Service (SATIS) in collaboration with the Advisory Council for Technology and support of the Department of Trade and Industry. Some 2 100 firms soon linked up with SATIS, which provided access to approximately 100 000 technical publications and handled approximately 6 000 enquiries per annum.
- Commissioning the National Accelerator Centre for research, the treatment of cancer patients and production of isotopes for delivery to hospitals and other research institutions.

The CSIR also founded Technifin, a R50 million venture capital company, jointly with the Industrial Development Corporation.

The Main Support Programme of the FRD, with substantial increased funding, had a massive impact on research at universities, technikons and museums. By 1989, the FRD had supported 808 researchers at these institutions after peer reviews on a truly international basis, awarded 1 300 postgraduate bursaries annually to students in the natural sciences and engineering, as well as 27 special merit bursaries to outstanding students for local and overseas studies.

Both Dr Rein Arndt and Dr Brian Clark were intimately involved in the establishment of the two separate councils, each with their own mission: The FRD as a funding council focusing on training high-level manpower and the CSIR as a research organisation with enhanced emphasis on technology transfer.

The CSIR ruled supreme in its formative years but was increasingly operating in an environment where universities engaged in contract research and the private sector increased its consulting engineering capacity. In 1990, the FRD operated on a budget of R108,4 million and the CSIR line-function divisions on a budget of R339,3 million.

By 2020, the budget of the NRF, successor to the FRD, amounted to R3 792 million (R564 million in 1990 prices) and that of the CSIR R2 758 million (R410 million in 1990 prices).

▶ *Any concluding thoughts?*

In the 1980s, the CSIR adhered to the International Council of Scientific Unions, which advocates the free association of scientists, regardless of race, colour, sex or political persuasion. In the spirit of the Wiehahn and Riekert Commission reports, investigations were initiated that led to several new initiatives. These included the introduction of an employees' association for all personnel, the opening up of all its amenities to all staff members, the desegregation of functions and meetings, the elimination of race-based salary discrimination and a declaration of Scientia as an area open to all races to allow the construction of accommodation on the site for visits by the CSIR's black bursars and scientists.

That was the old South Africa, now mercifully in the past. On 2 February 1990, I had a television installed in my office to witness the F W de Klerk speech in Parliament. I was quite emotional, realising that finally real change was in the air! Emerging from the massive team effort to change one institution, I realised the immensity of the task ahead to turn a country around.

The wisdom of Machiavelli more than 600 years ago, springs to mind:

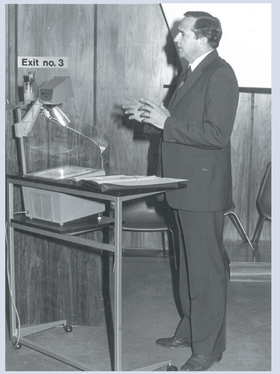
"It must be considered that there is nothing more difficult to carry out nor more doubtful of success nor more dangerous to handle than to initiate a new order of things; for the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order; this lukewarmness arising partly from fear of their adversaries... and partly from the incredulity of mankind, who do not truly believe in anything new until they have had actual experience of it."

Subsequent to my retirement in 1990 and due to knowledge gained at the CSIR, it was fulfilling to further participate in many of the post-1990 science, educational and industrial activities, as well as experience the privilege of international collaboration. It was a time worth remembering and I appreciate the opportunity to share those memories in this commemorative book.

My very best wishes for the road ahead.

Clockwise from top left: Dr Chris Garbers meets Taiwan's Premier, Sun Yun-suan, in 1982; at the commissioning of a new cable testing machine in 1989, with Dr Stefan Roell of the Roell and Korthaus Group, and the CSIR's Dr Albert Michau and Frider Hecker; addressing staff; welcoming Prof. Gunther Wilke, Vice-President of the Max Planck Institute for Coal Research in Western Germany to the CSIR; and joining Dr Louw Alberts, CSIR Chairman (centre) for the handing over of three CSIR merit awards to Dr Neville Comins, Dr Terry Watson and Francois Anderson in 1989.

Dr Chris Garbers 1980-1990



Dr Brian Clark

CSIR President
1990-1995

"The bottom line for us was the need to transform, rather than reform. This meant fundamentally realigning the CSIR's resources and capacity to respond to new opportunities for future growth."

▶ ***When and how did you join the CSIR?***

I started working at the CSIR in 1965 when I was 16 years old, on the day after writing my last matric paper. I wanted an education in science and my father had taught me from a young age that the way to success was to 'go out and do it'.

While this approach instilled in me a passion for results-driven performance, which served me well throughout my career, as a young lad it fuelled my desire to 'experiment'. Unfortunately when I was experimenting with shooting burning arrows once, I set alight the nursery of our family-owned flower business, which at the time, was a critical source of income for the family!

I remember my job interview with Dr Carl Pistorius, my first manager at the CSIR's National Physical Research Laboratory. He spoke about the qualities of great researchers and mentioned some who had been great collectors, one specifically of ancient art. I was excited, since I was also a collector and that meant I could become a great scientist too! I eagerly admitted to being a collector but was too shy to divulge the nature of my collection – how could company lapel badges compare to relics of Mexican art? – and pretended to have forgotten what it was. Despite the embarrassing 'memory loss', I was appointed as a laboratory assistant and 30 years later ended my career at the organisation as the sixth President (at age 41, also the youngest).

During my first 10 years at the CSIR, I studied part-time for my PhD with a CSIR study grant (one of the great benefits of working for the CSIR). At the time, I worked in a team in the High-Pressure Physics Laboratory and our research was at the cutting-edge of science. Although, as a team, we relaxed while socialising, professionally the atmosphere was extremely competitive. There was significant pressure to always have an answer to every question.

My post-doctoral studies, in Germany in 1974 through a Research Fellowship from the Humboldt Foundation and in the United States in 1975, exposed me to a variety of research cultures and confirmed my sense that there was nothing wrong with not always having an answer to everything. I also became more convinced of the merits of using research to contribute to industrial development.

Back in South Africa, the sudden death of Dr Pistorius almost resulted in the closure of the High-Pressure Physics Laboratory. I approached the De Beers Diamond Research Laboratories – while overseas, I had received but declined their job offer to become involved in industrial research – to negotiate a contract for the CSIR to conduct their industrial research. As a result, the High-Pressure Physics Laboratory did not close, instead doors opened for the CSIR to work directly with industry.

When Dr Chris van der Merwe Brink, CSIR President from 1971 to 1980, asked me to head up a materials programme in addition to the High-Pressure Physics Programme, I agreed. Upon reflection, the experience I gained in both those positions prepared me for three other appointments during my time at the CSIR: as Chief Director of the National Institute of Materials Research in 1983, Executive Vice-President for Technology Transfer in 1985 and successor to Dr Chris Garbers as CSIR President in 1990.

I greatly valued the opportunities to contribute to a world-class organisation.

▶ ***What were some of the highlights and key challenges during your term as President?***

When I took over as President in 1990, the CSIR Board had already approved a radical proposal about the future course of the CSIR. I was assured, confidentially but on good authority, that the Board regarded me as 'the man to make the new initiative work'.

By then, I was convinced of two things: that market-driven contract research was the right way to go and that bureaucracy within the CSIR and South Africa's political isolation had left us completely out of touch with our environment.

Two incidents occurred shortly after my appointment that I believe contributed significantly to the planning and implementation of the CSIR's future course.

Firstly, the insights of three leaders in industry – Paul Kruger, Chairman of Sasol, and Derek Keys, Executive Chairman of Gencor (before becoming Minister of Economic Coordination and Trade and Industry in 1991 and Minister of Finance in 1992), both of whom joined the CSIR Board in 1991 (Paul Kruger as Chairman from 1991-1995) and Warren Clewlow, Chief Executive of Barloworld at the time. Their wisdom about effective management and marketing added new dimensions to our thinking. Critically important was their advice that the CSIR's Executive team should focus on fewer issues, do them exceptionally well and use the organisation's marketing initiatives to position the CSIR in selected target markets. This laid the foundation for our watershed strategy of 1993.

Secondly, the release of Dr Nelson Mandela from prison in 1990 compelled us to understand how to position the CSIR for a future South Africa. This included interacting regularly with ANC stalwarts, such as Dr Frene Ginwala, ANC Research Director and Jayendra Naidoo, the first Executive Director of the National Economic Development and Labour Council (NEDLAC) in the mid-1990s.

Their insights, along with those of many of their peers, influenced much of our thinking and planning. It also gave me confidence that the CSIR, with its hard-won flexibility through framework autonomy, which by then had become part of the CSIR culture, would meet the challenges of a new and different future.

An incident that stands out in memory from that time – and I am sure that my executive colleagues will remember this as well as I do – is that within months of his release from prison, Dr Nelson Mandela elected to visit the CSIR. Naturally, we were excited to receive him. His very real interest in and intelligent assessment of the value of investing in research and development (R&D) to benefit the country and ordinary South Africans, made it a memorable visit.

But even more impressive during the visit was evidence of the measure of the man, as told by Fred Camphor, CSIR Chief Executive Human Resources, who met Mandela when he arrived.

After politely greeting his host, he (Mandela) immediately asked to use a telephone. Those were the days before cell phones locally. Just before leaving for the CSIR, Mandela had learnt that Minister Kobie Coetsee, South Africa's Minister of Justice under apartheid, had been hospitalised following a heart attack. He wanted an update on Coetsee's condition and to determine how he could assist the family. Twice more during the visit, he called for updates on Coetsee's condition. This empathy towards someone who, as Minister of Justice, had overseen most of his 27-year incarceration, truly showed the character of the man and the mettle of his leadership – loved and revered at home and admired and respected globally.

An important development during 1992, following a performance audit by the Auditor-General of South Africa, led to the removal of a loan and investment limitation imposed on the CSIR Board by the Minister of Trade and Industry. This had a positive effect on the cash flow management of the organisation.

One of the highlights during my five-year tenure as President, was the rapid entrenching of organisational learning in South Africa's new landscape to strategically operate as a market-driven national research organisation with 14 operational divisions and corporate programmes.

As indicated before, the lessons from Paul Kruger, Derek Keys and Warren Clewlow – to take decisive action, drive disciplined implementation, empower others to grow, cooperate with associates, within and outside the organisation and focus on niche marketing – became our pegs in the sand. The CSIR benefitted from this in growth, revenue and reputation.

I also regard the contribution by James Mullin as a significant highlight. We contracted him after the release of the International Development Research Centre (IDRC) report (mentioned later) to share international learning about supporting small, medium and micro enterprises (SMMEs) and developing communities with our employees. His insights as a consultant on science policy were well-received and enabled us to align our activities proactively with a wider range of the country's developmental needs.

By the time I left the CSIR in 1995, our external contract income from the private sector had increased to 60%, from R181 million in 1991 to R261 million in 1995, despite a reduction in staff from 4 133 in 1990 to 2 678 in 1995. The CSIR had also been registered as a consultant with the World Bank and African Development Bank, as well as various international entities.

We also appointed the first five CSIR Fellows – Prof. Piet Steyn, Willem Botha, Prof. Frank Nabarro, Prof. Bob Scholes and Francois Anderson – in recognition of their excellence in science and/or technology. And really important at the time, was that employee and stakeholder satisfaction surveys indicated that approval rates had improved significantly – in fact, 77% of stakeholders expected the CSIR's contribution to the new South Africa to be significantly positive.

▶ ***What were the CSIR's major contributions to national priorities and science and technology during your tenure?***

South Africa's political reforms led to positive shifts in attitude internationally towards the country and the CSIR. This opened up many new opportunities for us. Our international strategy focused on investments and cooperation agreements, including those with the Technical Laboratory of Uruguay, Ministry of Science and Technology in Argentina, Ministry of Works in Malawi and the Industrial Technology Research Institute in Taiwan, the latter confirming the mutual recognition of national measuring standards.

We prioritised an 'Into Africa' drive that supported a range of projects, from road maintenance in Botswana and Malawi to power station and tunnel design in Zimbabwe and building failure investigations in Zambia. In fact, a CSIR mining team working with architects from Marais, Pretorius and Wenhold won an international competition in 1991 for the design of the Engela Mission Hospital in Namibia.

We also focused on commercialising technologies that met market needs to increase competitiveness within industries locally. Our challenge was to balance the technology needs for competitiveness with those for development and respond effectively in all areas. A commissioned study in 1992 helped us to position the CSIR more effectively as a technology provider to SMMEs and coordinate our activities through a corporate Technology for Development programme.

During that time, the CSIR/AECI lysine production process led to the commissioning of a R300 million fermentation plant, completed in 1995, to produce 11 000 tons of amino acid annually. We also developed a unique intelligent electro-optical intruder-detection system with world wide patents and the Kangela online ash monitor to process coal quickly and efficiently.

I remember 1993 as a watershed year for the CSIR. A new government, representing the majority of South Africans, implied a shift in priorities for the CSIR. We knew that collaborating with the new decision-makers and key players in government was the most constructive path to pursue for the well-being of the country and its people, as well as to maintain the CSIR's position as the continent's strongest science and technology infrastructure.

The CSIR was listed as a public entity by an Act of Parliament in 1993, with its activities determined by the country's science policy and system of framework autonomy for science councils. By that time, our external contract income had increased by a further 20% despite revenue contractions from some government departments. We created world-class expertise in technology management and invested our parliamentary grant income prudently – an approach that attracted positive reactions globally.

1993 also saw the conclusion of the ANC-commissioned International Development Research Centre sponsored study on a science and technology policy for South Africa and the findings report, *Towards a Science and Technology Policy for a Democratic South Africa*. Led by Dr Frene Ginwala, the study assessed the country's science and technology entities and highlighted the needs that we had to address.

Primary among them were applying technical skills to real development needs, committing to non-racist and non-sexist affirmative action programmes and for the science and technology community to acknowledge its location in Africa to participate actively in formulating the new policy.

The report shaped our science and technology environment. It led to the Science and Technology Initiative (STI), co-chaired by myself and Jayendra Naidoo, which became a truly inclusive forum on science and technology in the country.

Dr Brian Clark
1990-1995

Clockwise from top left: Dr Brian Clark welcomes Mathews Phosa, the first premier of South Africa's Mpumalanga province to the CSIR. Clark is flanked by Dr Fred Kruger, Director, CSIR Division of Forest Science and Technology, and Abbey Chikane. Phosa is flanked by Neo Moikangoa, CSIR Executive Vice-President: Technology for Development and Mike Groch, CSIR Executive Vice-President: Commercial; comparing notes on a new transmission electron microscope with the CSIR's Dr Mike Shaw, Dr Neville Comins and Dr Alan Bentley in 1985; exchanging gifts with Dr Chintay Shih, Executive Vice-President of the Industrial Technology Research Institute of the Republic of China in 1991; and congratulating his colleagues who also were named Fellows of the Royal Society of South Africa, Dr Louw Alberts (seated), Dr Koos Fourie (left) and Dr John Vogel.

Lessons from the IDRC report, STI discussions and a CSIR-commissioned survey to determine internal and external stakeholder needs, opinions and perceptions were welcomed by future government respondents, female and black CSIR employees and NEHAWU shop stewards. We also recognised it as a first step in ongoing communication and cooperation that would be critical to our future.

The bottom line for us was the need to transform, rather than reform. This meant fundamentally realigning the CSIR's resources and capacity to respond to new opportunities for future growth. Our 1993 five-year strategy identified three technology avenues: competitiveness, decision-making and development. We also adopted the slogan: *Your Technology Partner.*

Some of our major contributions during my final two years at the CSIR included the incorporation of the Chamber of Mines Research Organisation into the CSIR in 1993, led by Dr Geoff Garrett who took over as CSIR President in 1995.

Others included helping big business to become more competitive with better technologies and decision-making tools and helping small entrepreneurs in urban and rural communities with technologies for chicken abattoirs, rural bakeries, water systems for individual homes, house-building and facilities for achar production and small-scale saw milling.

International relations escalated through cooperative agreements and international contracting with partners in Asia, South America, the Middle East and the United States of America, with technology exports such as the CSIR's heavy vehicle simulator. Our collaborative projects with a range of countries in Africa grew at a tremendous rate, with a focus on infrastructural and environmental technology solutions, as well as technologies for urban and rural development and energy- and agricultural-related challenges.

A wide range of joint ventures, such as between the CSIR and the South African National Civic Organisation, provided urban and rural communities with technological support that improved their livelihoods. We also contributed to national policy formulation, which included the establishment of the National Science and Technology Forum at the time.

I took great pride in the way our people adapted to the need for integrated, multidisciplinary task teams that responded effectively to large projects. Examples include the St Lucia environmental assessment and the development work for the Lesotho Highlands Water Project. Experts from five disciplines in four CSIR divisions collaborated internally and with external subcontractors to complete the projects successfully and to international acclaim.

▶ *What could/should the CSIR's contribution be in future?*

As an acknowledged national asset and recognised for its research excellence globally, I am sure that the CSIR's performance will continue to make a compelling case for the value of research and development and technological innovation.

Undoubtedly, the organisation will increase its ability to respond proactively and strategically to national priorities and – given the current imperatives of a fourth industrial revolution reality – support public and private sector clients alike to function optimally within the dynamics of a digitised world.

Extended networks, including with fellow developing-world scientists, should be front-of-mind to meet and exceed the world's sustainable development goals. I have no doubt that the CSIR's Africa-specific knowledge and its meaningful contributions to the use of quantum computing, nanotechnology, artificial intelligence and augmented reality will help to eradicate hunger and alleviate child mortality, poverty, contagious diseases and illiteracy quicker and more effectively.

I see the CSIR's trajectory as a continuum of applying its R&D infrastructure, capacity and science and technology capabilities to improving humanity's current reality and its future outlook. I have no doubt that it is up to the challenge.

▶ *Any concluding thoughts?*

If track record is a viable indicator of future performance, the CSIR has demonstrated clearly its resilience and ability to adapt to rapidly changing environments. I am proud to have shared a part of that journey. It was and always will be a team effort.

I remain grateful to have 'grown up' in an organisation that offered me my first job and the ability to fulfil my dream of a career in science. The opportunities over 30 years to learn, experience and implement new knowledge and work with like-minded people, were invaluable to my own development and in my post-CSIR career.

I appreciate the opportunity to contribute to this coffee table book and to remember and celebrate a unique and remarkable story. The CSIR's 75-year legacy will live on in our memories and I have no doubt that a rewarding future beckons.

Congratulations on a memorable and commendable milestone!

Dr Geoff Garrett

CSIR President
1995-2000

"In addressing the challenges of a new South Africa, the CSIR embarked on an evolutionary process of realignment with new realities. We unambiguously sought to lead in providing a comprehensive range of technological solutions and information as a partner to all our constituents."

Bottom line first? Fifteen great years, with never a doubt that it was the right move to make! But backtracking a bit... As a Brit by origins, I married a South African. Janet and I met as students at Cambridge and I only went to South Africa in 1972, to get married. Discovering Cape Town and that was it – hotfooting it back, as soon as my PhD was finished, to take up a temporary junior lectureship at the University of Cape Town for two years (max). We stayed for 30.

I enjoyed my 13 years as an academic, ending up as Professor and Head of the Department of Metallurgy at Wits University in Johannesburg. But – in the mid-80s – things were on the move at our national research agency, a charge led by the dynamic and talented Dr Brian Clark. He encouraged me to jump the academic ship to head up the (then) National Institute for Materials Research (NIMR). Equally encouraging, I might add, were my interactions with the wise, experienced and well connected President at that time, Dr Chris Garbers.

Elsewhere in this book you will read Brian's account of his leadership journey and the cultural and organisational transformation he spearheaded. It was a privilege and a great learning experience to be one of his team near the beginning, and through those major change processes. This included five exciting years (1990-95) as one of his two EVPOPs (Executive

Vice-President: Operations) with my close colleague, Dr Daan Toerien. 'Chalk and cheese' personality and style wise, some might say, but I guess that's partly why Brian picked that twosome...

Having shared acting as President for much of 1995 when Brian headed off to run Telkom, the CSIR Board – under the chairmanship of business icon, Dr Bill Venter – put me into the presidential seat later that year, our organisation's 50th.

▶ ***What do you recall as highlights – and key challenges – during your term as President?***

Twenty plus years on, it has been an eye opener to read through those five years of annual reports. Wow! One forgets how much we got done, successfully, in parallel (and complementing) the transformational societal migration our whole country was experiencing.

Change – ongoing and significant – is the overriding recollection.

Joined with the pride around these necessary – and strategic – changes being (largely) successful, epitomised by the short, pacey and goosebump-inducing video we produced with the Blue Moon production company while I was still an EVPOP (which won a Golden Loerie Award from the SA Association for Marketers!) and which – coupled with an original soundtrack – we entitled "It's Working"... and it was.

Despite the enormity of organisational and, for many, personal changes, our 1999 Employee Satisfaction Survey results showed ongoing improvement with an overall satisfaction index of very close to our target of 75% (which was at the top end of industry norms), with a leadership satisfaction score of just on 90%.

So, linking highlights and challenges, unsurprisingly inseparable, first off, **transformation** – of the diversity and experience base of both our leadership team and workforce as a whole – in line with the national imperative, was indeed a challenge. Communicating 'affirmative action' – and implementing it – was (and I guess remains) hard, disciplined, thoughtful work – and no overnight exercise. We made some appointment mistakes, plus we lost some good people who left some big operational holes. But we also got lots right.

Brian had approached Neo Moikangoa, erstwhile Cornell mathematician, a senior member of the ANC, a poet and speaker of most of the new South Africa's 11 official languages, to help lead our critically important Technology for Development (TfD) thrust – itself requiring major re-orientation of our research agenda, and corresponding financial investment (not without pain, of course, in our more 'traditional' areas of research endeavour).

And when Brian's astute human resources professional, Fred Camphor, decided to go back to the private sector, we found the delightful, effective and well-connected Dr Namane Magau.

Both Neo and Namane were powerful influencers on my executive team, helping to role model at the most senior level what diversity of perspective can achieve. Tina Eboka's appointment to head up our Textile Division was also instrumental in helping convey 'we are serious about this'. As was, in the gender equity imperative, Petro Terblanche's earlier appointment as the organisation's first female Division Director.

At 'the other end' of the organisation's hierarchy, I was really pleased with the progress we made, in relatively short order, in early-stage career recruitment. Illustratively, by 1999 just on three quarters of our 116 bursars were black, and 40% were female.

Moreover, in navigating this complex transformation journey, we were immensely fortunate with the appointment of both Roger Jardine (later to become CSIR Chairperson) in his capacity as the top departmental Director-General to whom we reported, and in having Dr Ben Ngubane as our Minister of Science and Technology. Good men, both. And a small, illustrative anecdote about Ben. Flying down to Cape Town on one occasion to meet with him in his office there, I fell ill and was hospitalised off the plane. More than just accepting our apology for missing our catch up, Dr Ben changed his diary and came to visit me. That's the sort of person he was. Like many, I was saddened to hear of his passing in 2021.

But beyond the transformation of our workforce, it was necessary to also significantly transform our research and services portfolio, aligned with new national priorities. Thus, our cross-cutting and multi-divisional TfD programmes provided the lens through which we reviewed our business agenda, for example: helping create jobs and working in new ways with SMMEs in providing technical extension, training, technology demonstration and access to high-level technologies; engaging with the provinces and local councils in support of environmental sustainability (such as water-use, sanitation, waste disposal and air pollution); creating new apprentice training opportunities in-house and greatly expanding our outreach programmes to schools and their teachers and students. From intensive collaboration with the crime prevention agencies through to working with the management of national sports teams, such as Bafana Bafana, in game analysis, was an exciting – often daunting – period for out-of-the-box thinking and action.

Around **other highlights** (each with concomitant challenges), let me pick just three.

Firstly, improving **industry engagement**, continously "putting the 'I' in CSIR" – was a goal Brian Clark had (rightly) begun to push hard. By 1999 we had increased our externally generated contract revenue – a useful metric of the value of the agency to external stakeholders – to close on 60% of total revenue, representing significant year-on-year growth and, by 1999/2000, 7 000 contracts were being undertaken.

Noteworthy was the success we achieved in implementing our strategy to grow our business and our research and development (R&D) impact in South Africa outside Gauteng, in SADC countries and elsewhere in Africa.

Correspondingly (and happily!), our regular and independent stakeholder satisfaction survey results increased positively to exceed 80% in 1999 in the excellent/very good/good category.

Relatedly, a focus on the importance of the commercialisation of our research, including company spin offs, was paying dividends. Early success included transferring our Internet-based technology platforms Worldnet Africa and Compuserve to MNet in the private sector. Later, and building on the CSIR's subsidiary and licensing/funding organisation, Technifin, we established Technovent as a technology ventures company to acquire and incubate proven technologies into commercially viable enterprises.

At the same time, our international contract income – always highly competitive – blossomed, with some double digit growth years, increasing to 58.4% of total contract income in the 1999/2000 financial year. Working with some major corporations across the globe was always career-enriching for our scientists and technologists.

Secondly, **partnerships and collaboration** were increasingly central to our *Growth with Impact Strategy*. Again, in the global context, we joined eight other CSIR-sister organisations from around the world to form the Global Research Alliance (GRA) under the remarkable leadership of Dr Ramesh Mashelkar, Chairperson of CSIR India, well supported by our stalwart international lead, Dr Reinie Biesenbach.

Partnering, too, facilitated the growth of specific international business opportunities, in the UK/Europe with the collaboration, then takeover of niche engineering consultancy, Quo-Tec, and in Australia through a joint venture with Perth-based mining consultants, Snowden Associates.

Dr Geoff Garrett
1995-2000

Clockwise from top left: Dr Geoff Garrett hosts members of the media in 1990 with, from left, Dr Daan Toerien, Director: CSIR Manufacturing and Aeronautical Systems Technology; Tom Roy, Assistant Editor of the Pretoria News; and Norman Chandler, Head of the Pretoria Bureau of The Star; handing an award to Piet van der Westhuizen, Business Development Manager at the CSIR Satellite Applications Centre with Jeanne Basson and Danie Perold looking on; learning more from the CSIR's Gunther Meyer; welcoming the Parliamentary Subcommittee on Science and Technology during a visit to the CSIR in 1996 with, from left, Dr Wally Serote, Mahomed Cassim, Prof. Ismail Mohamed, Dr Adi Paterson, CSIR Executive Vice President: Technology and Policy, and Calvin Neluvhola; and at the signing of a memorandum of agreement for the National Metrology Laboratory (NML) to operate the National Measuring Standards with, from left, Dr Bruce Foulis, Manager of the NML; Dr Zac Rustomjee, Director-General of the Department of Trade and Industry; and Johann Ahlers, Director of CSIR Manufacturing and Aeronautical Systems Technology.

Closer to home, but still with global opportunities in mind, we enlarged our scope of activities and skills base by absorbing both the Fishing Industries Research Institute and AECI's R&D Department.

Vision is, of course, always important in the leadership domain. Thus cognisant of both physical proximity and R&D parallels with the CSIR and the University of Pretoria (UP) – and through excellent dialogue with UP's world-class Vice-Chancellor, Prof. Johan van Zyl – the concept of SERA, the Southern Education and Research Alliance, was born, later morphing into The Innovation Hub, ably led by the CSIR's highly competent Dr Neville Comins.

Thirdly, memories are strong – and positive – around **teamwork and leadership development**. First off, getting the Executive and Division heads to work as a well-functioning team was always a top priority, but, taking into account the rich diversity of strong personalities, no easy task!

Close at hand to facilitate this engagement, over months and years, we had the indefatigable international leadership coach, Ian Dean. Enthusiastic, pushy, insightful and fun – we all looked forward to (and look back upon fondly) our stimulating team-building sessions. Beyond that, Ian developed and led our Advanced Leadership Programme for middle and senior leaders in the organisation. Always with hot competition for places, over a five-year period, starting in 1995, Ian helped skill up more than 300 CSIR leaders.

Experience gained here also led to the launch and growth of CILLA, our popular CSIR Innovation Leadership and Learning Academy.

► *What do you think you got right over that time?*

Maybe I should let others be the judge of that. But in so doing, I might point to some of the awards and recognition our organisation, our divisions and our people received over this time, for example: the overall winner of a national Corporate Governance Award, and winner in the Best Medium-sized Organisation category; a National Science and Technology Forum Award for the most outstanding contribution to Science, Technology and Engineering; an International Association for Impact Assessment Regional Award; a number of Technology Top 100 Awards; a Gold Award for Equity in the Workplace; and an Engineering Week/Engineering Association 'Best of the Best Products' Award.

And if, as we often said, "Feedback is the Food of Champions", the comprehensive report we got back from our visiting international review group – involving India's Dr Mashelkar, whom I have already mentioned, as well as Dr Bert Westwood, formerly Corporate Vice-President for R&D, Lockheed Martin Corporation, USA – could not have given us healthier, indeed most complimentary, sustenance!

But if there's one thing I'm proudest of getting right, it's the people thing. At the **leadership level**, working hard together, and individually, in developing and implementing our Board approved strategies, it would be grossly remiss of me not to mention my exceptional Executive colleagues: Mike Groch, Albert Jordaan, Namane Magau, Neo Moikangoa, Daan Toerien and Anthos Yannakou.

Our outstanding group of Division heads over that time, including: Johann Ahlers, Brian Armstrong, Jan Becker, David Bath, Neville Comins, Tina Eboka, Ben Fouché, Johan Fritz, Guner Gurtunca, Phil Hendricks, Dieter Krueger, Fred Kruger, Roy Page-Ship, Adi Paterson, Hoffie Maree, Duncan Martin, Maurice McDowell, Piet Steyn, Harry Swart, Petro Terblanche and Ben van Vliet also deserve special mention.

Further, in the science leadership space, our world-class CSIR Fellows were important role models for the organisation, including Francois Anderson (aeronautics), Prof. John Napier (mining), Prof. Bob Scholes (environment) and Prof. Piet Steyn (food science).

Equally, the **support team** I was fortunate to work with was top drawer: from my very professional, exceptionally hard-working executive assistants Louise van der Merwe and Christa Fryer; my dedicated executive officer, Dr Bruce Foulis; our calm and knowledgeable board secretary, Sarie Burgess; my quality 'go to' person in the communications group, Amie Hunter; the forensic and energetic head of internal audit, Johan Hattingh; and my long-suffering 'lift club' buddy, George Matlala who drove with me (and freed me up) back and forth between our home in Johannesburg and Pretoria for all of 11 years!

► *What didn't work out as you'd hoped?*

Embarrassingly, getting to grips with Afrikaans! Try as I might, and never the linguist, despite several two-week 'full immersion' courses under my belt, with everyone so fluently bilingual, rarely did I get the chance to practice in the high pressure work environment – except when some amusement was required.

► *Any thoughts in conclusion?*

Back to my opening comment – 15 great years! I am privileged to have had the opportunities that the CSIR provided me to work with so many gifted and enthusiastic people, our scientists and support staff, our leaders, our Board and our diverse stakeholders, partners and clients.

Overarchingly, the one thing I've learnt, time and again: it's all about relationships. All business is people business.

Happy 75th! With grateful thanks, and the very best wishes.

Dr Sibusiso Sibisi

CSIR Chief Executive Officer
2002-2016

"It is perhaps emblematic of modern South Africa that the CSIR can reconcile the duality of a chequered history with the many scientific and technical accomplishments during its first 75 years; and that its people can proudly reflect on the scientific achievements of their predecessors while recognising the fundamental injustice of the system within which those achievements took place."

I settled down to pen my contribution to this commemorative book shortly after the final track event of the memorable Tokyo Olympic Games – the men's 42.2 km marathon race. Even as fellow athletes succumbed to the oppressive heat, Kenya's Eliud Kipchoge majestically coasted to a second gold medal in two successive Games. The first and only human to date to complete a marathon in under two hours (August 2019) and only the third man in Olympic marathon history to defend his title, the legendary Kipchoge crossed the finish line as a commentator effused, "We have never seen the like of him before, we will never see the like of him again!"

As the beaming Kipchoge firmly held his gold medal in his grip, it seemed fitting to think of the word "grip" as shorthand for "grit, resilience, inspiration, performance". Despite the image that the word "game" may convey, the Olympic Games symbolise much more than victory over others. More than anything, it symbolises the triumph of the human spirit over limits that we assume nature to have imposed upon us.

Only a few days before Kipchoge, the world had been enthralled by South Africa's Tatjana Schoenmaker as she set the world record in the 200 m breaststroke. The quest to do better is an irrepressible human virtue that the Olympics so grippingly bring to the fore.

There can hardly be a metaphor more apt than the Olympics for humanity's equally relentless pursuit of knowledge. Beyond the quest to know more, it is also a quest to do better with what we know in order to make people's lives better and for all of us to be better people. The cumulative body of knowledge that we refer to as science is a critical underpinning of this relentless quest for the better.

The CSIR resides at the nexus between scientific knowledge and a better world. Its mandate talks the idea, its people walk the ideal. At a deeply personal level, that is what drew me to the CSIR. What I inherited from able past leadership, what I sought to nurture, promote further and eventually bequeath to future leadership. The tight coupling of impeccable governance, meticulous research, commitment to making a difference, all brought together by passionate people, suggests another take on the notion of a firm grip: "governance, research, innovation, people". The reference to people can and must be understood in its intended dual meaning of people who make up the CSIR community and people in broader society who are ultimate beneficiaries of the work of CSIR people.

In a similar vein, innovation is closely coupled to impact. I have chosen the expression "tight coupling" advisedly. It conveys the notion of joined-up activities of high quality better than a descriptor like "balance", say, which can be construed in ways at odds with the intended message. A see-saw attains balance when the higher end necessarily comes down in order for the lower end to come up.

By contrast, all four elements of the CSIR's GRIP must get stronger together, rather like all four walls of a building under construction must rise together and be tightly joined together. The leadership challenge that flows from this objective of doing it all together is precisely what I found so fulfilling during my tenure as CEO of the CSIR. There is a related sense that, at global level, we need to do it all together. The world is besieged by global challenges: the Covid-19 pandemic, climate change, health, water and energy demand and so on. The tight coupling of these challenges makes the case for global scientific cooperation to address global challenges for the global good.

The CSIR had firmly recognised the importance of its role in this regard and it will undoubtedly continue to do so. It may be possible to generate a litany of outputs in any particular tenure in the form of research papers, patent applications and the like. I resist the temptation to do so here because there are others within the CSIR who are far more adept at telling stories about the successes and impact of the work of the CSIR. The institution has the good fortune of an outstanding group of communication people. The CSIR's highly acclaimed *ScienceScope* publication bears testimony to this. Should one wish to learn more about the work and people of the CSIR, there can be no better place to start than with the *ScienceScope* series. Accordingly, I shall not dwell here on a detailed description of what is more engagingly covered in *ScienceScope*, complemented of course by annual reports and associated sources.

In conclusion, I find myself musing whether the alarming challenges of our times do not call for a metaphor beyond maintaining a firm grip on what we have attained. We need new ways of thinking to dial up our respect for the environment and for one another as a global community. A havoc-wreaking pandemic and freak climate events seem like nature is getting a little impatient with the more subtle signals that we are in dire need of profound introspection. The CSIR research community has, for some time, had much to say about the need for harmony between people and planet. The growing global refrain is that the time for action is now.

A transition is called for: from a rather passive grip to an assertive grasp: "governance, responsibility, action, science, {people, planet}". Requisite action is, of course, multi-faceted. But the undisputed centrality of good science in response to pandemics, climate change, energy, water and health lends undisputed credence to the abiding maxim: Our future through science.

From left, top row: Dr Sibusiso Sibisi at the CSIR Excellence Awards in 2005; inaugurating a new X-band antenna at the CSIR Satellite Applications Centre in 2002; announcing the winners at the CSIR's 2014 Excellence Awards; (middle row) encouraging learners at a CSIR Career Day in 2016; learning more about a CSIR-developed camera that displays defects in high-voltage electrical installations in 2009; addressing the media about the CSIR's annual report in 2009; (bottom row) taking part in discussions alongside Dr Ramesh Mashelkar, former Director-General of the Council of Scientific and Industrial Research in India at De Hoek, South Africa in 2002; promoting the CSIR during a media interview; and sharing in the excitement of the build-up to the 2010 Soccer World Cup in South Africa.

Dr Thulani Dlamini

CSIR Chief Executive Officer
2017 to date

"We look forward to a productive and mutually beneficial working relationship with all our partners and stakeholders as we use science, technology and innovation to support industrial development and the development of a capable state. In so doing, we will contribute to addressing the triple challenge of unemployment, poverty and inequality, which will improve the wellbeing of all South Africans holistically and comprehensively."

How did you join the CSIR?

My career, to date, has been split almost equally (in years) between two thoroughbred South African icons – Sasol, a private sector company rooted in a proudly South African heritage, and the CSIR, with its 75-year track record in technological innovation at the tip of Africa. I have left and rejoined both these entities and feel a sense of loyalty to both.

I first joined the CSIR in 2005 as manager of the CSIR National Laser Centre, after having started my career at Sasol and having gone through the ranks there from scientist to chief scientist in heterogenous catalysis and materials characterisation research. I was the second manager at the CSIR National Laser Centre, succeeding Dr Phil Mjwara, the current Director-General of the Department of Science and Innovation. Three years on, I was appointed by Dr Sibusiso Sibisi as the CSIR's Group Executive for Research and Development, but was then lured back to Sasol, as I was keen to expand my experience in private sector management. I became General Manager: Research and Development in 2011 and Vice-President: Strategic Research and Technology in 2014, but the CSIR had the final say in the duel, when I was appointed Chief Executive Officer in 2017.

The impact potential of the CSIR has always excited me – I realised that if we harness our multidisciplinary capabilities and maximise the application of our collective intellectual capacity, we really have a chance of changing the fortunes of the people of South Africa. That has always drawn me to the CSIR.

You are the ninth leader of a 75-year old organisation in a country with a chequered history. Do you have anything in common with the Presidents of the past?

While the CSIR's objectives have always centred on making an impact through scientific research, through the sacrifices of many, the South African societal context has changed for the better, and for that we are grateful. To use multidisciplinary research and technological innovation to help improve the quality of life of the people of the South Africa at a time that the world is going through major technological advances brought about by the fourth industrial revolution, is indeed a privilege. At the same time, we are expected to address the significant social and economic challenges that our country faces. I am proud to be leading the CSIR in this context and I am committed to our objective of touching lives through innovation.

In many respects, I represent rural South Africa. I come from humble beginnings, having grown up in a small village in KwaZulu-Natal. The first time I came into contact with science was in grade 11, when I went to boarding school in Mariannhill; something I share with my predecessor at the CSIR, Dr Sibusiso Sibisi, who went to the same school. I understand the struggle context, and how an educational lifeline, such as a bursary, can change someone's life and future prospects.

Societal context aside, there are probably similarities with previous Presidents and Chief Executive Officers. The CSIR has had many leaders of impeccable scientific and academic acumen. No local university has sole bragging rights in this context, with the universities of Stellenbosch, Pretoria, the Witwatersrand (Wits) and Rhodes all featuring in former CSIR Presidents' curricula vitae. Cambridge University in the United Kingdom, however, can count three former CSIR Presidents as its alumni. I studied at Wits, where I developed a keen interest in research during my Honours year, finishing top of my class in industrial chemistry and receiving a medal from the South African Chemical Institute. Research and development has been my passion ever since.

It may be fair to say that a common thread among the leaders of the CSIR is the passion for making a difference in South Africa, through the use of science, engineering and technology. This is coupled with a concomitant inclination to lead a multidisciplinary team of leaders, scientists and engineers who are specialists in their domains; to be able to do this effectively requires a certain level of humility.

What is the essence of the CSIR's current strategy, which you have been driving for the last few years?

After I joined the CSIR in 2017, we took a very thorough look at the current South African context and the CSIR's contributions in this regard. We had to acknowledge some stark realities, such as the declining growth in some of the country's traditionally strong industries. It was clear that the CSIR was coming up short in its support for industrial development. While we wanted to continue to support a capable state – serving the needs and requirements of the public sector – we needed to pay attention to how we support industrial development if we wanted to achieve the intentions of our mandate.

The new strategy identifies high-impact sectors in which South Africa can carve out a competitive advantage, and defines strategic focus areas and initiatives that could bring competitiveness in the specific sectors of the economy and stimulate overall socioeconomic growth. We took into consideration our current capabilities and where we would be able to grow our competences. The strategy focuses on nine technology sector clusters and supporting initiatives. Six clusters focus on the advancement of very specific sectors: chemicals, manufacturing, mining, defence and security, health and advanced agriculture and food. Three clusters focus on industry and society enablement to ensure that we have smart places, next-generation enterprises and institutions, as well as smart mobility.

The strategy required changes to our operational model. Change inevitably takes a lot of energy and grit, but we have made the changes and are now implementing the strategy and beginning to see the dividends.

While we most certainly did not foresee the Covid-19 pandemic, it emphasised that we were on the right track and that we need science, engineering and technology to become force multipliers that contribute to the recovery of the South African economy, which had retracted even further since the start of the pandemic. True to our mandate, we were able to apply our research to support a capable state through a

number of Covid-19-related interventions, including the development of a novel, easy-to-use locally manufactured ventilator; the first locally manufactured Covid-19 diagnostic assay in collaboration with CapeBio; and a data platform to collect and analyse Covid-19 data for weekly reports to the National Coronavirus Command Council.

▶ *How tough has it been to be CEO in the time of Covid-19?*

It has been as tough for me as it has been for every South African – most people have been adversely affected. We have lost loved ones and colleagues. Families have had to survive on less. People's mental wellbeing continues to be under strain. As CEO, it has, of course, been a burden to carry the collective strain. Just trying to ensure that staff don't get sick at work has caused me much personal anguish. Add to that the stress of the global economy coming to a standstill and having to then get it going in a pandemic-ridden world makes for the most challenging circumstances imaginable. But, our organisation has learnt a lot in the past year – how to adapt and innovate within the ever-changing circumstances. We have learnt about working from home, home schooling, reaching out to those with Covid-19, all while working to meet as many of our performance targets as possible. In a sense, we have had to cling on to the values we had adopted in 2018, to survive 2020 and 2021. We pursue excellence (regardless of how much our circumstances challenge us); we are people-centred (we care for and support one another); we value integrity (we are committed to ethical decision-making); and we collaborate to ensure that our work has the best chance of creating a better future. We have proven that CSIR people are resilient.

▶ *What does the future hold?*

If anything, I am more excited now about the CSIR's impact potential than I was before I started. I have now had a taste of it. When my colleagues relayed that they received a call from a doctor at a local hospital thanking them for the lives saved following a Saturday night emergency intervention to provide the hospital with CSIR-developed ventilators during the worst of the Covid-19 wave, I felt immensely proud. When I see the benefits of granting small, medium and micro enterprises access to our equipment and experts to develop world-class products and processes, I am energised.

I am not naive about the challenges of the future, but, through the collective ingenuity of our people, we truly can touch lives through innovation and we look forward to the centennial celebrations.

Dr Thulani Dlamini
2017 to date

Clockwise from top left: Dr Thulani Dlamini addresses CSIR women at the launch of the CSIR Women's Forum in 2021; welcoming (then) Deputy President Cyril Ramaphosa to the CSIR in 2017; addressing staff at the sixth CSIR Conference in 2017; with executive colleagues Dr Molefi Motuku and Dr Rachel Chikwamba at the 2018 CSIR Excellence Awards; representing Team CSIR at the 2019 CSIR Race; introducing Deputy Minister of Higher Education, Science and Technology Buti Manamela to CSIR technologies; and discussing radar technologies with CSIR research group leader for electronic warfare Reeshen Reddy in 2017.

TRACKS THROUGH TIME –
RETRACING OUR FOOTSTEPS

Timelines take us back in time or propel us into the future. They enliven our memories of what and where, when, and sometimes even why, events happened. And they give context to how what went before, can give promise to what lies ahead.

Commemorating the CSIR's diamond jubilee in this book celebrates a journey through past events – one that traces footprints that trod deeply and encourages reflection about the many remarkable achievements, the challenges that were overcome, the commendable progress made and the lessons learnt along the way.

The size of this book allows us to depict only a small selection of those events. The different timelines on the following pages pinpoint memorable milestones, landmarks and turning points. The timelines highlight infrastructure developments at our Scientia campus and elsewhere in the country, and profile a small selection of our inventions and innovations.

We also spotlight a number of the CSIR's significant awards, give recognition to recipients of the country's highest honour, and present the strategies and structures that directed us towards our vision and the shareholders with oversight of our mission. The final timeline offers a photo collage of some of the many thousands of visitors who spent time at the CSIR.

A journey through these timelines attests to how local ingenuity gave substance to South Africa's advancement and affirms the CSIR's significance as a national asset and its stature as a respected scientific and technological resource among peers and partners worldwide.

BUILT AND EQUIPPED OVER 75 YEARS — AN INFRASTRUCTURE TIMELINE

"We shape our buildings; thereafter, our buildings shape us." – Winston Churchill, October 1943, during a debate about the shape of a reconstructed Commons Chamber following its destruction during the Blitz in 1940

1945

A NATIONAL RESEARCH ORGANISATION

A **national research organisation**, the Council for Scientific and Industrial Research (CSIR), is established in terms of the Scientific Research Council Act, 1945 (Act 33 of 1945) of the Parliament of the Union of South Africa. Initially, the CSIR was headquartered in Visagie Street, Pretoria.

SCIENTIA

The CSIR receives, as a gift from the University of Pretoria in 1948, 100 hectares of the university experimental farm east of Pretoria, Gauteng. In 1950, additional land was purchased to create what is still known today as **Scientia**. The first building erected was a 3 m wind tunnel of the National Mechanical Engineering Research Institute. The National Building Research Institute was the first laboratory built and occupied in 1954.

1948-1954

1956

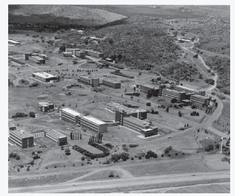
CYCLOTRON

The National Physical Laboratory's **cyclotron** is officially inaugurated by Dr A van Rhijn, Minister of Commerce and Industry. It was used for the production of radioisotopes for diagnostic purposes, and for research and training.

SITE DEVELOPMENT

A number of **new buildings** are erected on the Pretoria site, including the main buildings for the National Physical Research Laboratory and National Mechanical and Engineering Research Institute (NMERI) (1957), National Institute for Water Research (1958) and National Food Research Institute (1959). Seven more buildings house the National Chemical Research Laboratory (1960), main building of the Technical Services Department (1962) and the NMERI Hydro and Thermo buildings (1962 and 1963). Also in 1963, the National Research Institute for Mathematical Sciences opened its doors, followed by the National Institute for Transport and Roads Research in 1964.

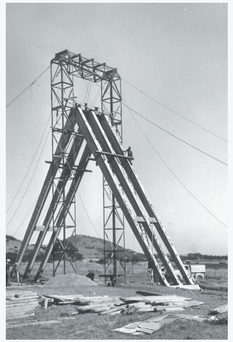
1957-1967



1958

COMPUTING

A **computer**, code-named ZEBRA, manufactured in England, is installed to supplement the CSIR's analogue computer, built by the National Physical Research Laboratory. It was used mainly to speed up the analysis of research data in various fields. The computer occupied an entire room of about 36 m^3.



1959

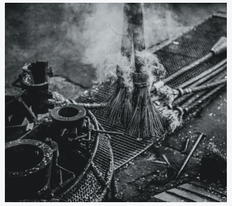
A-FRAME GATE

The CSIR completes its signature **A-frame entrance**, which would later be used as a symbol in the organisation's first logo.

RADIO SPACE RESEARCH

The CSIR inaugurates Hartebeesthoek as the South African **Radio Space** Research Station.

1961



1964

MECHANICAL AND ROPE TESTING LABORATORIES

The CSIR takes over the 1935-built Government Mechanical Laboratory, known today as the CSIR Mechanical Laboratory in Cottesloe, Johannesburg. It is equipped with two of the largest **mechanical testing machines** in South Africa, which accommodate large-load test specimens used in mine support products, hoisting equipment and lifting gear. Tests are performed in compliance with legislative standards and to promote the general safety of workers. The Rope Testing Laboratory was established in 1970 at the same site and in 1989 a larger rope testing machine was taken into use and remains in use today.

CARBON DATING FACILITY

The CSIR builds a **carbon dating** facility 15 m below ground surface for age determination of natural substances. The facility, which won international acclaim at the time, was one of only two of its kind in the world.

1967

1968

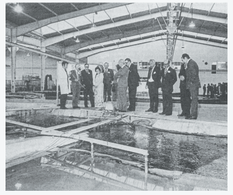
OCEANOGRAPHIC RESEARCH VESSEL

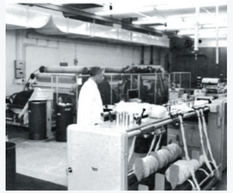
The CSIR launches the *Meiring Naude*, its own **research vessel,** equipped with a wet laboratory, electronics laboratory and biological/chemical laboratory for multidisciplinary oceanographic research.

HYDRAULICS RESEARCH UNIT

A **hydraulics** research unit is established in a new building with a large model hall near the Stellenbosch University in the Western Cape. It follows the growing demand for applied research in **coastal engineering**, arising mainly from the projected major harbour developments at Richards Bay and Saldanha Bay.

1969





1971

WOOL AND TEXTILES RESEARCH INSTITUTE

The South African Wool and Textile Research Institute becomes a national institute of the CSIR, focusing on all **textiles**, including synthetic fibres. In 1974, the President of the CSIR, Dr Chris van der Merwe Brink, officially opens a new cotton processing department.

CONFERENCE CENTRE

The CSIR Conference Centre – a modern, well-equipped **conference venue** – opens in Pretoria, Gauteng. In 1979, some 30 500 people attended meetings in the centre. In 2019, the CSIR International Convention Centre welcomed 75 000 people.

1977

1978

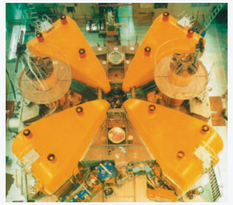
SATELLITE REMOTE SENSING CENTRE

The CSIR establishes the Satellite Remote Sensing Centre at Hartebeesthoek, 50 km north-west of Johannesburg, Gauteng, following the withdrawal of the National Aeronautics and Space Administration from South Africa. The facility receives and processes **Earth observation data** and provides **satellite tracking** and data acquisition services. The centre later became the CSIR Satellite Applications Centre and was incorporated into the South African National Space Agency in 2010.

FLUIDISED-BED COMBUSTION PLANT

Shortly after the National Institute for Coal Research became part of the CSIR, a national **fluidised-bed combustion** plant is inaugurated. This is an important step towards using that part of South Africa's mined coal which would otherwise go to waste. With this technology, coal too fine for combustion in conventional commercial boilers could be used and coal with a high ash content could be fired.

1984



1986

NATIONAL ACCELERATOR CENTRE

The National Accelerator Centre, with its headquarters at Faure in the Western Cape, is formally opened. The **cyclotron**, which was capable of producing a beam of subatomic particles accelerated to a maximum energy of up to 200 million electronvolts, meets the needs of South African scientists interested in cancer therapy, the production of radioisotopes and basic research.

COAL-DUST EXPLOSION TEST FACILITY

The G P Badenhorst Coal-dust Explosion Test Facility at Kloppersbos near Pretoria, Gauteng, becomes operational. The size and location of the facility enable controlled large-scale coal-dust/methane explosions to test and evaluate products used to prevent and mitigate **in-mine explosions**. It is also used for large-scale live demonstrations as part of mineworker safety awareness training.

1987

1988

MEDIUM-SPEED WIND TUNNEL

The CSIR medium-speed wind tunnel is constructed and the aerodynamics research capability expanded. CSIR wind tunnels are used in **aerodynamic design** tests and studies for local and international clients in the aeronautical sector.

SELF-CONTAINED SELF-RESCUER LABORATORY

The CSIR establishes the Self-Contained Self-Rescuer Laboratory after the annual sampling and testing of **self-contained self-rescuers** becomes a statutory requirement in the same year. These devices supply mine workers with oxygen during emergencies that result in an irrespirable atmosphere such as fires or explosions underground. The testing of these devices contributes to the decrease in incidents of defective units in mines.

1996

2000

MEDICINAL PLANT EXTRACTION FACILITY

A medicinal plant extraction facility for the production of complex botanical mixtures for use in human trials is established at the CSIR. The facility is used to supply plant-derived materials in clinical trials. It supports the drive to maximise the potential of South Africa's **indigenous plants**.

KA-BAND SATELLITE TRACKING FACILITY

Construction starts on the world's first **Ka-band satellite tracking** facility at the CSIR Satellite Applications Centre at Hartebeesthoek.

2000

2004

SCIENCE AND TECHNOLOGY DEPARTMENT ON SITE

The Minister of Science and Technology, Dr Mosibudi Mangena, turns the sod for the construction of a **new building** to house the department on the southern side of the CSIR campus. CSIR President Dr Sibusiso Sibisi and Mangena expressed their approval at the prospect of being close neighbours.

CENTRE FOR HIGH PERFORMANCE COMPUTING

The Centre for High Performance Computing is launched in Cape Town by the Minister of Science and Technology, Dr Mosibudi Mangena. The centre affords local researchers the advantage of using **massive computing power** in their quest for new knowledge and applications.

2007

2007

NATIONAL CENTRE FOR NANO-STRUCTURED MATERIALS

The Minister of Science and Technology, Dr Mosibudi Mangena, launches the National Centre for Nano-Structured Materials, where researchers study and create **nanomaterials** to benefit various industries.

KNOWLEDGE COMMONS

The CSIR Knowledge Commons, a dedicated **space for** furthering science through **dialogue** and **networking**, is launched and hosts its first external speaker.

2009

2010

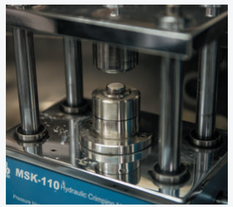
CONTAINMENT LABORATORY FOR PATHOGEN RESEARCH

The CSIR launches a state-of-the-art **containment level 3 laboratory** for experiments involving HIV and tuberculosis (TB) pathogens where researchers conduct research and proof-of-concept studies for new HIV/Aids and TB diagnostics or therapeutics. In 2020, at the start of the Covid-19 pandemic, the CSIR repurposed the laboratory to help expedite government's **Covid-19 testing**.

BATTERY RESEARCH CENTRE

The CSIR establishes a battery research centre to develop low-cost, safe and **long-lasting batteries**. New equipment to make battery coin cells, analyse the capacity of batteries, and take atomic-scale photographs of surfaces of printed electrodes, is installed.

2010



2013

TITANIUM PILOT PLANT

Minister of Science and Technology Derek Hanekom launches a titanium pilot plant following the development of a novel CSIR-patented process to produce primary **titanium metal**. South Africa has large reserves of titanium-bearing minerals and the ability to economically extract the mineral from the mineral concentrate could help create a new downstream industry.

3D PRINTER FOR ADVANCED MANUFACTURING

A large 3D printer for titanium parts is demonstrated at the CSIR. This advancement in **additive manufacturing** makes it possible to manufacture parts for the aerospace industry as part of the pursuit of lighter aircraft. The printer produces geometrically complex parts to specification and minimises material wastage.

2014

2014

HYDROGEN RESEARCH INFRASTRUCTURE

Hydrogen research infrastructure is launched to aid research into **hydrogen storage**. The facility, which forms part of Hydrogen South Africa, is launched by the Minister of Science and Technology, Dr Naledi Pandor. Hydrogen is of interest as a clean energy alternative to fossil fuels.

NANOMATERIALS INDUSTRY DEVELOPMENT FACILITY

The Nanomaterials Industry Development Facility is launched for the production and industrial testing of **nano-structured materials**. The facility, launched by the Minister of Science and Technology, Dr Naledi Pandor, helps industries to generate materials with improved properties, made possible through nanotechnology.

2015

2015-2017

SOLAR PHOTOVOLTAIC PLANTS

Three solar photovoltaic plants are installed on the CSIR campus in Pretoria. The plants have a 1 008 kW power output and mark the start of the journey to **sustainable energy integration** on the CSIR campus.

BIOMANUFACTURING INDUSTRY DEVELOPMENT CENTRE

The Biomanufacturing Industry Development Centre is launched at the CSIR in Pretoria to stimulate the growth of the **biomanufacturing** industry. The facility, launched by the Minister of Science and Technology, Dr Naledi Pandor, contributes to the conversion of research and development outputs into products commercialised by small and micro enterprises and established industry.

2016

2018

BIOREFINERY INDUSTRY DEVELOPMENT FACILITY

The Biorefinery Industry Development Facility in Durban, KwaZulu-Natal, is launched to help ensure that maximum value is extracted from **biomass waste**. The facility, launched by Minister of Science and Technology Mmamoloko Kubayi-Ngubane, supports innovation in a range of biomass-based industries, including forestry and agro-processing.

PHOTONICS PROTOTYPING FACILITY

The Photonics Prototyping Facility is set up to help grow South Africa's photonics industry. The facility speeds up the product development of **photonic technology** and devices.

2020

INVENTIONS AND INNOVATIONS THAT PUT IDEAS TO WORK

"An invention has to make sense in the world it finishes in, not in the world it started." – Tim O'Reilly, founder and CEO of O'Reilly Media

1954

ELECTRONIC DISTANCE MEASUREMENT

Dr Trevor Lloyd Wadley invents the first microwave electronic distance measurement equipment, the **tellurometer**. The tellurometer revolutionised land surveying throughout the world. In 1956, a company, Tellurometer Ltd, was formed in Cape Town to exploit the invention and the first production model appeared in 1957. The company set up to manufacture the tellurometer maintained the market lead for this equipment for over 25 years.

ACCELERATED PAVEMENT TESTING

The **heavy vehicle simulator** is developed to accelerate the testing of road pavement materials by achieving the effect of 20 years of traffic on a road surface within three months. It earned South Africa more than R250 million in foreign revenue.

1965

1980s

LITHIUM-METAL-OXIDE ELECTRODE MATERIALS FOR BATTERIES

The CSIR contributes to **lithium-ion battery** research through the discovery of lithium-metal-oxide electrode materials with a spinel-type structure. Today, lithium-ion batteries power our smart phones, laptop computers, electric vehicles, smart grids and even our homes.

LIGAMENT REPAIR

The bollard – a medical device used in conjunction with a prosthetic ligament for the repair of cruciate ligaments in the knee – is invented based on research into **carbon-fibre surgical implants**. More than 60 000 of the locally manufactured devices are sold over three decades, the last sale being an order of 250 units in 2013.

1982

2000

BREATHABLE LAMINATED TEXTILES

The CSIR transfers and commercialises its **breathable laminated technology**. The technology is suitable for the manufacture of protective outerwear and garments for healthcare workers, providing protection against virus transfer. BreatheTex Corporation (Pty) Ltd, an SMME with a small CSIR shareholding, goes on to earn the Jürgen Schrempp Award for Excellence in 2002 at the South African Excellence Foundation Innovative Strategies for Competitiveness Conference.

WATER-SOLUBLE POLYMER GEL TECHNOLOGY

The CSIR licenses its **water-soluble polymer gel technology**, which becomes the basis for Eyeslices innovative cryogel eye treatment pads, which won numerous awards, including a Technology Top 100 Award in 2007.

2000

2002

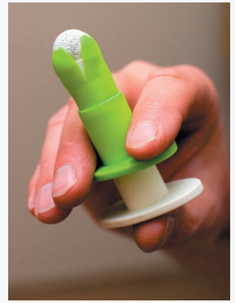
ARMOURED VEHICLE FOR CASH-IN-TRANSIT INDUSTRY

A new **armoured multipurpose vehicle** offers better protection to safely transport cash for the cash-in-transit industry. It features improved mobility and better weight distribution, making it harder to overturn.

MOSQUITO REPELLENT CANDLE

The CSIR and owners of indigenous knowledge sign a benefit-sharing agreement that led to the development of a locally produced **mosquito repellent candle** using the oils of indigenous plants. Tests had shown that the essential oil of the indigenous plant, *Lippia javanica*, has more effective repellent properties than comparable products on the market. This led to the granting of a licence to formulate the patented extract into mosquito repellent products, such as candles.

2003



2004

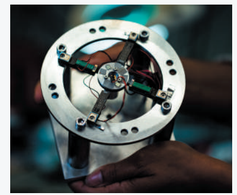
ORBITAL IMPLANT

The Eyeborn orbital implant is launched at the annual international conference of the Ophthalmological Society of Southern Africa following years of research into bioceramics for medical applications. Eyeborn is a hydroxyapatite **orbital implant** used to replace the eyeball of a patient who has lost an eye. The first sale by the local distributor was to an ophthalmic surgeon from Zambia.

DOUBLING CAMERA IMAGE RESOLUTION

The CSIR patents a micro-scanning mechanism that enables the **image resolution** of a locally developed defence digital infra-red camera to **be doubled**, without the need to use a higher specification sensor.

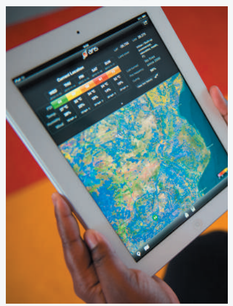
2004



2005

ADVANCED FIRE INFORMATION SYSTEM

The CSIR develops the **Advanced Fire Information System** (AFIS), which uses satellite data to detect fires in real time and automatically send warnings directly to users via cell phones and tablets. By 2012, AFIS was available as a mobile app. AFIS provides free wildfire information services to users around the globe, and value-added content for CSIR customers.



2008

CAMERAS THAT DISPLAY CORONA DISCHARGE

A range of **cameras** that visually displays the **corona** discharge around defective, high-voltage electrical installations is licensed to UViRCO Technologies. The company captured some 50% of the world market and, in 2020, the powerline inspection system became the first ever to radiometrically quantify the ultraviolet light emitted from pylons.

2009

ENCAPSULATION TECHNOLOGY FOR CASH-IN-TRANSIT HEISTS

A system that encapsulates the entire contents of an on-board vault in a solid block of **polyurethane foam** when a heist is detected, helps reduce cash-in-transit heists.

2011

DIGITAL DOORWAY

The CSIR-developed **Digital Doorway**, a computer terminal equipped with educational games and applications, design functions and access to the Internet, is named one of the top 50 inventions in the world by *Time Magazine*.

2012

EUCALYPTUS CLONE

A ***Eucalyptus* clone** developed by the CSIR and its collaborators is awarded the First Plant Breeders' Rights for *Eucalyptus* locally. New tree breeds that have better pulping properties help counter predicted shortfalls in the supply of wood.

2012

MOUTHPIECE AND NOSECLIP FOR SELF-CONTAINED-SELF RESCUERS

The CSIR licenses its patented rubber **mouthpiece**, used in self-contained self-rescue breathing apparatus, to Afrox. These rescuers supply mine workers with oxygen during emergencies such as fires or explosions underground. Earlier, the CSIR also redesigned a nose clip that was distributed globally, with over half a million units sold worldwide.

2013

ULTRASONIC SYSTEM TO MONITOR RAILWAY LINES

In collaboration with Armscor's Institute for Maritime Technology, the CSIR co-develops an **ultrasonic system** that monitors heavy-freight **railway lines for breaks**, remotely and in real time. Transnet Freight Rail installs the world-first system on its 860 km-long Sishen-Saldanha iron ore line and the system wins the top award in the technical category at the annual Armscor CEO Awards.

2014

MICROSPHERE TECHNOLOGY

The CSIR licenses its patented **microsphere technology** to CSIR spin-out company ReSyn Biosciences (Pty) Ltd. Microspheres are tiny beads onto which molecules can attach. MagReSyn® microspheres maximise the surface area for molecules to bind on. They bind targets very specifically and have helped to boost drug development, diagnostics and industrial processes.

2014

DEPLOYING SMALL VESSELS FROM MOVING SHIPS

The South African Navy successfully demonstrates the operational viability of a CSIR-designed **davit system** to deploy a small vessel from a moving ship during, for example, **anti-piracy operations**. The system compensates for dynamic deck loading, as well as wave movement through a hydraulic wave-compensating system, which matches the movement of the waves to the movement of the boat being deployed.

2015

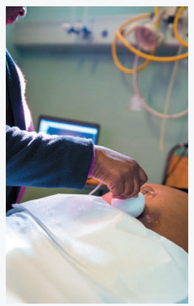
ECO-FRIENDLY BIOLOGICAL PRODUCTS

OptimusBio, a CSIR spin-out company, introduces a range of eco-friendly biological products for sanitation, water treatment, aquaculture and agriculture to the market. The company manufactures **biological products** that contain active beneficial bacteria. The CSIR had been developing *Bacillus*-containing products for several years.

DETECTING FETUSES AT RISK OF STILLBIRTH

Clinical trials of a simple, cost-effective Doppler **ultrasound device**, called the Umbiflow, starts in Tshwane in Gauteng. The device can determine, at the primary point-of-care, whether a **fetus** that is deemed small for gestational age **is healthy or potentially sick**. The device uses ultrasound to measure blood flow in the umbilical artery of a third trimester fetus to assess placental sufficiency or insufficiency. The trial shows a 50% reduction in stillbirths in the community.

2015



2016

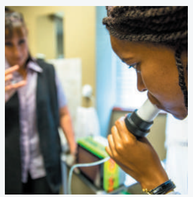
GREEN COMPONENTS FOR AIRCRAFT

The CSIR and commercial airliner Airbus are granted joint patents in 2016 and 2017 on the development of non-load-bearing interior **aircraft panels** using the **natural fibre, flax**. The team combined woven flax fabric with phenolic resin (a synthetic polymer) to replace glass fibre composites. The CSIR also developed and patented an environmentally friendly, flame-retardant treatment to comply with the aerospace industry's fire, smoke and toxicity requirements.

BREATH-ANALYSING GLUCOMETER

A South African patent is granted for a CSIR-developed **breath-analysing glucometer** to replace invasive finger-prick glucometers for monitoring diabetes. The device detects acetone, a by-product in the breath of a person with very high blood sugar levels through the use of a micro-nanochip. In 2019, clinical trials were undertaken in collaboration with the University of Pretoria, followed by an application for registration with the South African Health Products Regulatory Authority in 2020.

2016



2018

SMART SPECTRUM MANAGEMENT

The Independent Communications Authority of South Africa gazettes a regulatory framework for commercial use of television whitespaces (TVWS). This was made possible by the CSIR's development of a **smart spectrum management** tool, the outcome of research into dynamic spectrum management. TVWS technology uses the gaps, known as white spaces, between terrestrial television broadcasts to deliver affordable broadband networks. The innovation won a National Science and Technology Forum award in 2020.

ENCAPSULATION TECHNOLOGY

The CSIR licenses its patented **encapsulation technology for probiotics** in which the active ingredient is enclosed to provide a barrier against moisture, high temperatures and gastric fluids. The technology is based on the combination of two novel ideas, namely the encapsulation of the probiotic in a pH-responsive interpolymer complex and an encapsulation process occurring in an anaerobic supercritical carbon dioxide environment.

2019

2019

ENHANCED CREW ESCAPE SYSTEM

The CSIR and Armscor develop a new prototype system that **enhances** originally fitted **crew escape systems** in submarines of the South African Navy. The safety of submariners depends on their rapid and safe escape from a stricken submarine on the seabed. The submarine tower escape safety system was the outcome of a project initiated by the South African Navy in conjunction with Armscor, the Institute of Maritime Technology and the CSIR.

2019

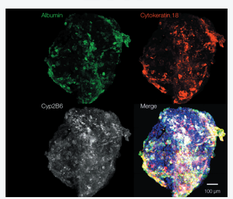
ENZYME MANUFACTURING TECHNOLOGY

The CSIR licenses its **manufacturing technologies** for the local production of DNA ligase and DNA polymerase **enzymes** to CapeBio Pty Ltd. The molecular biology enzyme reagents had been isolated from South Africa's indigenous biodiversity using metagenomics techniques. Biotechnology research and development activities rely heavily on the use of proteins and enzymes as reagents. This work laid the foundation for what would become the first locally developed PCR (polymerase chain reaction) test kit and reagents to test Covid-19 in 2021.

MICROLIVERS FOR DRUG-SAFETY TESTING

The CSIR succeeds in generating **microlivers** from induced pluripotent stem cell-derived cells from individuals of African descent. The researchers grow these tiny artificial livers in petri dishes to replace human and animal subjects for **drug-safety testing**. They grow them from induced pluripotent stem cells, which are a cutting-edge, ethically acceptable type of stem cell that is not extracted from human embryos. The milestone is regarded as a significant breakthrough in the research on providing information for the **best treatment outcomes** for high-impact diseases in South Africa.

2019



2019

PLANT-BASED VETERINARY VACCINES

The CSIR, in collaboration with the University of Pretoria, successfully produces highly efficacious candidate **veterinary vaccines** for influenza in *Nicotiana benthamiana* (tobacco) plants. The CSIR, in collaboration with its research associates at the University of Cape Town and Onderstepoort Biological Products, had also filed a patent during 2017 for its proprietary vaccine candidates against African horse sickness and the Bluetongue virus, and published the work in acclaimed international journals.

EASY-TO-USE VENTILATOR

The CSIR helps alleviate the impact of the Covid-19 pandemic by developing a novel, easy-to-use **ventilator** system. The ventilator uses standard, hospital-grade oxygen supply, and features easy-to-use, on-device flow gauges to adjust the fraction of oxygen-enriched air in steps of 10% oxygenation. Several collaborators assist in the design, manufacturing and distribution of the ventilator, which had been evaluated by the South African Health Products Regulatory Authority.

2020

2021

BIOCIDES

A CSIR formulation of **biocides** for Biodx (Pty) Ltd is registered as the only type two and four biocides from Africa in the European Union. These types of biocides refer to products used as **surface disinfection for food contact** and general surface disinfection, respectively. The two products have been tested against Covid-19 and have a kill rate of 99.987% within seconds of application. The commercial partner sells ton quantities of the products to different local and international markets.

AWARDS AND RECOGNITION

"The value of achievement lies in the achieving." – Albert Einstein to D. Liberson, 28 October 1950

The power of awards and recognition is that it increases engagement, inspires performance and keeps you at the top of your game. In this awards timeline, we feature a selection of CSIR awards and achievements over the years.

2014

2016

2018

2020

2013

2015

2017

2019

Since first competing in the **Student Cluster Competition of the International Supercomputing Conference** in 2012, South African undergraduate students have won the competition four times (in 2013, 2014, 2016 and 2019), and taken second place three times (in 2015, 2017 and 2020). The competition is the last stage of a year-long programme to introduce students to high-performance computing (HPC). HPC is a relatively new field in South Africa and the CSIR-managed national facility in Cape Town boasts one of the largest processing clusters on the continent – a collection of networked processors that provides the computing power needed to solve complex computing problems.

2020

- South Africa's largest energy efficiency initiative, the SA Industrial Energy Efficiency Project, is named the International Energy Project of the Year, awarded by the global Association of Energy Engineers. The project is managed by the National Cleaner Production Centre of South Africa (NCPC-SA), which is hosted by the CSIR on behalf of the Department of Trade, Industry and Competition.
- The CSIR receives its 12th consecutive annual clean audit award from the Auditor-General of South Africa (since 2008).

2019

- The CSIR receives its ninth consecutive annual Top Employer certification since 2010, and two Universum Awards for Employer of Choice in Natural Sciences and Engineering/Technology as voted for by students and professionals.

2018

- The Eco-Logic Awards recognise the CSIR's bioplastic technology for contributing to a sustainable world.
- The Meerkat team, consisting of the CSIR, the South African National Parks (SANParks), the Peace Parks Foundation and the K9 Unit of the Southern African Wildlife College, receives the SANParks Kudu Innovation Award for helping to reduce poaching in the Kruger National Park.

2016

- The NCPC-SA wins the Best Training Provider in the Public Sector category of the Achiever Skills Development Awards for its training courses.
- The Cmore platform for shared awareness, used to counteract poaching, takes second place at the Rhino Conservation Awards in the Best Science Research and Technology category.
- Africa's fastest supercomputer at the time, *Lengau*, hosted at the Centre for High Performance Computing, is included on the international Top 500 list of super computers.

2015

- ReSyn Biosciences, a CSIR biotechnology spin-off company, wins a prestigious new product award for its range of innovative MagReSyn® products, which help scientists find disease mechanisms faster.
- The CSIR's enterprise creation for development activities receive the Award for Business Incubation and Information at the Forging Enterprise 2015/11th Annual Meeting and Forum of the International Network for Small and Medium Enterprises.

2013

- An ultrasonic system that monitors heavy-freight railway lines for breaks and a solution to deliver unbroken video streams over mobile networks are named project winners in the National Science and Technology Forum-BHP Billiton awards.

2011


2013

2015


2018

2018

2020

- South Africa, along with eight African partner countries, is awarded the right to host the mid-frequency component of the Square Kilometre Array, in part, thanks to the CSIR's critical contribution to demonstrating the country's efficient connectivity and processing capabilities.

2012

2011

- The CSIR Meraka Institute receives a Technology in Government in Africa Award in the ICT in Education category for Dr Math, a mobile mathematics tutoring programme.
- The Digital Doorway, a computer system that gives access to information on health, education and other relevant issues, co-created by the United Nations Children's Fund and the CSIR, is cited by *Time Magazine* as one of the top 50 inventions in the world for 2011.
- A CSIR/Santam proof of concept about the impact of climate change on the insurance industry results in a Climate Change Leadership Award in the financial category for Santam.

- The CSIR is a finalist in the Metropolitan Oliver Empowerment Awards for its outstanding achievement as a leading black-empowered company in the government agency/parastatal sector for outstanding contribution to the growth and sustainability of the South African economy.

2009

2006

- A portable landing light system for peacekeeping forces entering areas by air at night or in poor light receives recognition in the International Soldier Technology 2006 Forum Awards in the Best Operational Assessment for New Equipment category.
- The CSIR receives the Eskom Chairman's Award for the Advanced Fire Information System.

- The Zayed International Prize for the Environment, awarded for scientific and or technological achievement in the environmental domain, goes to scientists, including several CSIR scientists, for their work on the Millennium Ecosystem Assessment.

2005


1997


1999

1999


2000

2003

- BreatheTex, a company rooted in CSIR technology, earns the Jürgen Schrempp Award for Excellence at the South African Excellence Foundation Innovative Strategies for Competitiveness Conference.

2002

- The CSIR and the eThekwini Municipality are awarded the National Planning Award of the South African Planning Institute in the category, Best Regional Planning/Policy Planning Project.
- The CSIR receives a Silver Arrow Award in the PMR Intelligence annual survey of state-owned enterprises and parastatals, designed to assess their overall business efficiency and contribution to social development in South Africa.
- The CSIR is recognised by the Black Management Forum as one of the top 10 South African companies making a genuine impact in the empowerment of South Africa.
- The CSIR Foreign Missile Exploitation Team wins the prestigious Armscor Chairman's Award.
- CSIR Transportek receives the Fourth International Transport Award (Millennium Award) in Paris, France.

2001

- CSIR Manufacturing and Materials Technology receives the Presidential Award for Export Achievement in the category for research and development.

2000

- The Lekoa Vaal Road Building Unit Development Project receives top honours at the Impumelelo 2000 Awards.
- The CSIR's Manguzi Wireless Internet project is named a winner in the Equal Access category of the Stockholm Challenge 2000. The Stockholm Challenge Award is a non-profit initiative of the City of Stockholm (Sweden) in partnership with the European Commission.
- The CSIR's technical and scientific support helps to secure a silver medal for the Department of Water Affairs and Forestry's Working for Water programme in the prestigious Commonwealth competition: The International Innovators Award 2000.

1999

- The CSIR celebrates two achievements: Being named overall winner of the Corporate Governance Award for 1999, as well as winner in the best medium-sized organisation category.
- The CSIR Satellite Applications Centre is awarded the 1999 South African Excellence Foundation Award (level 2) for its culture of quality and business excellence.
- The CSIR receives the National Science and Technology Forum Award for the most outstanding contribution to science, engineering and technology by a corporate organisation.

1998

- CSIR Defence Technology is a winner in the National Quality Awards in the defence category.
- The CSIR Satellite Applications Centre receives a special award for business commitment and customer orientation at the SPOT IMAGE International Sales Network Seminar in France.

1997

- MineRisk, a CSIR Miningtek product that assesses and manages risks in the mining industry, receives a Top Products Award for its contribution to the South African economy as a commercially viable innovation.
- The CSIR receives a Golden Loerie Award for its corporate video and a Craft Award for script, performance, camera and lighting from the Association of Marketers in recognition of creativity and excellence in advertising.

1996

- CSIR Material Science and Technology receives a Top Technology 100 Awards in the research and development category and Aeroflo, a CSIR/Atomic Energy Corporation joint venture company, in the material and manufacturing category.
- The CSIR receives the Top Products awards for its SeamCam and Mine Hoist Cage Door.
- The stope support design methodology developed by the CSIR Division of Mining Technology is judged one of 20 top products in the Engineering Week/Engineering Association's Best of the Best competition.

1995

- The CSIR receives an International Association for Impact Assessment Regional Award for outstanding achievement in impact assessment in the southern African region.
- The CSIR receives the International Techtextil Innovation Prize for the development of new applications and products for the design of a five-spoke carbon composite motorcycle wheel.
- CSIR Textile Technology receives a Top Technology 100 Research and Development Award.
- The CSIR receives a Certificate of Accomplishment from the International Society of Photo Instrumentation Engineers for 50 years of achievement in optical engineering.

1994

- The Technology Key Products '94 Award is presented to the Commercial Internet Services of the CSIR Division of Information Services.
- The CSIR Division of Materials Science and Technology is awarded the 1994 Innovation Award of the SA Institute of Chemical Engineers.
- The SABITA Research Award is presented to the CSIR Division of Roads and Transport Technology.
- The CSIR Division of Roads and Transport Technology receives the SA Chartered Institute of Transport Award.

1993

- The CSIR Division of Energy Technology wins the Research and Development Category of the Technology Top 100 Awards.

1992

- A team from the CSIR's Mining Programme collaborated with architects from Marais, Pretorius and Wenhold to win an international competition for the design of the Engela Mission Hospital in Northern Namibia and the provision of a development plan for all health facilities in the region.

1991

- The CSIR receives a Technology Top 100 prize for excellence in scientific research and development.
- CSIR founder and first President, Sir Basil Schonland, is honoured on a commemorative stamp by the South African Post Office.

1990

- The CSIR receives the trophy for the best stand at the Electra Mining '90 Exhibition.

1984

- The CSIR's National Electrical Engineering Research Institute receives a Shell Design Award for a lightning warning system designed in conjunction with Spescom (Pty) Ltd.
- The bollard, a medical device used in conjunction with a prosthetic ligament for the repair of cruciate ligaments in the knee, receives the Chairman's Award for Excellence from the SABS Design Institute (at the time called the Shell Design Awards).

In 1991, the South African Post Office issued a set of four stamps depicting four great South African scientists. One of them was the CSIR's first President, Dr Basil Schonland.

- The CSIR's National Timber Research Institute receives a scientific award in the United States of America for the development of adhesives based on wattle and pine extracts. These adhesives replaced expensive and scarce imported chemicals used in the manufacture of particleboard, plywood and corrugated cardboard.

1980

1979

- The Post Office issues a special stamp to commemorate the invention of the tellurometer system of distance invented by the CSIR's Dr Trevor Wadley.

1971

- The Joburg Satellite Tracking and Data Acquisition Network at Hartebeesthoek (later CSIR Satellite Applications Centre) is rated as the top network station (May and June 1971) by the National Aeronautics and Space Administration's Goddard Space Flight Centre.

1969

- A water reclamation plant for the Windhoek City Council, jointly designed by the CSIR and a South African firm of consulting engineers, is opened in (what is now) Namibia. CSIR-developed processes are used to recover drinking water from sewage. The reclaimed water constituted 22 to 27% of the city's drinking water. The combined project team received the National Award of the Associated Scientific and Technical Societies of South Africa.

1957

- International acclaim for CSIR engineers for being the first to track and correctly predict re-entry of Sputnik-1, the world's first artificial satellite.

In 1979, to mark the invention of the tellurometer, the South African Post Office issued a special commemorative postage stamp carrying pictures of the prototype instrument and its inventor, the CSIR's Dr Trevor Wadley.

Dr Chris van der Merwe Brink, 1980.

The recognition of CSIR leadership dates back to before the introduction of the current national orders. Shortly before his death in 1980, CSIR President Dr Chris van der Merwe Brink received one of South Africa's highest honours for excellent service from President Marais Viljoen. A number of (former) CSIR staff members also received the SA Decoration for Meritorious Service, including Dr Meiring Naudé (1982) and Dr Gerrie Stander (1987).

Prof. Thokozani Majozi, 2019.

THE HIGHEST HONOUR

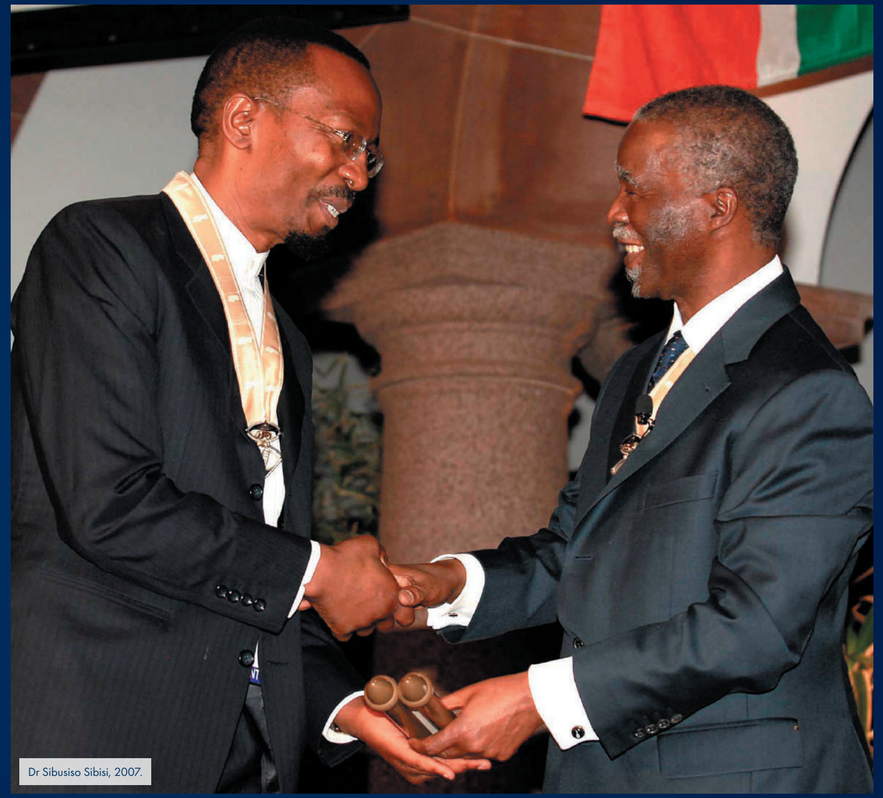
The Order of Mapungubwe is the highest honour bestowed upon an individual by the President of South Africa to recognise globally acknowledged achievements that serve the interests of the country. The Order honours the ancient Mapungubwe nation that existed a thousand years ago in the northern part of South Africa's Limpopo province.

Since its inception in December 2002, when former President Nelson Mandela was one of the first recipients, the Order of Mapungubwe has only been awarded 50 times. Impressively, to date, 10 CSIR employees, former CSIR employees or CSIR Fellows have laid claim to this prestigious accolade.

The CSIR's founding president, Sir Basil Schonland, was the first CSIR recipient (posthumously in 2002, gold) for his contribution to physics. Following in his footsteps were Prof. Tshilidzi Marwala (2004 bronze), for contributions to engineering science and Prof. Frank Nabarro (2005 silver) for contributions to academics and physics; former CSIR Chief Executive Officer Dr Sibusiso Sibisi (2007 silver) for contributions to information technology and research and development; Prof. Phuthi Ngoepe for his contributions to the development of computer modelling studies at the University of Limpopo (2008 silver); Prof. Johann Lutjeharms (2010 silver) for contributions to and achievements in oceanographic science; Prof. Piet Steyn (2011 silver) for contributions to and achievements in chemistry and biosynthesis of mycotoxins; Dr Patience Mthunzi-Kufa (2012 bronze) for contributions to biophotonics; Prof. Fulufhelo Nelwamondo (2017 silver) for contributions to science, particularly electrical engineering; Prof. Thokozani Majozi, current CSIR Chairperson (2019 bronze), for his contributions to the development of a novel mathematical technique relevant to wastewater optimisation. They all serve as a significant inspiration to the people of South Africa. In 2002, at the unveiling of the National Orders, President Thabo Mbeki acknowledged CSIR industrial designer Gold Mametja for his contributions to the design of the Orders.

Prof. Fulufhelo Nelwamondo, 2017.

Dr Patience Mthunzi-Kufa, 2012.



Dr Sibusiso Sibisi, 2007.

ACTUALISING THE VISION – A TIMELINE OF STRATEGY AND STRUCTURE

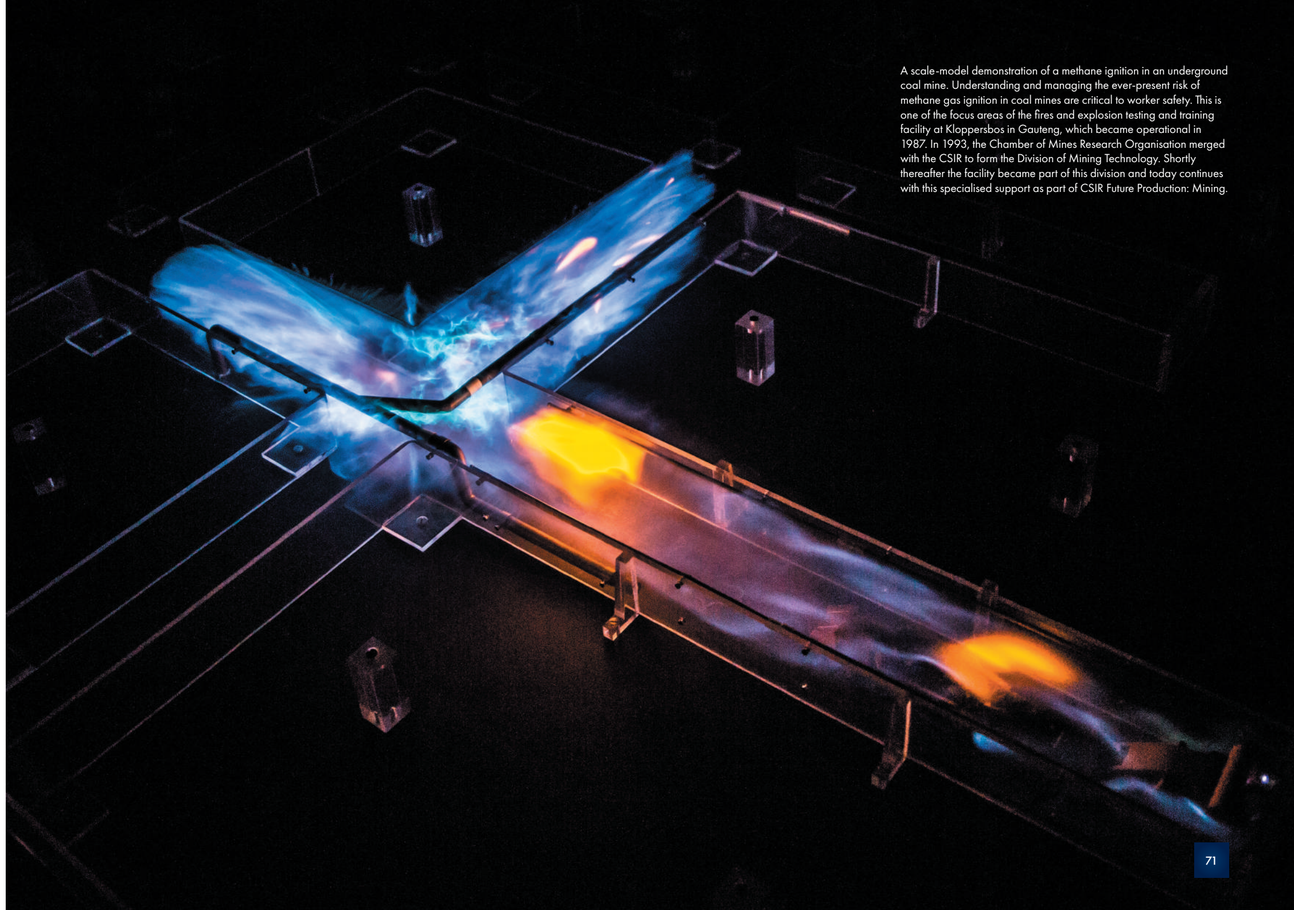
Books generally tell a story of impressions, experiences and expectations, but more often, it is the chronology of events that gives it direction.

This abridged chronology identifies the major strategic events of the organisation, and captures the opening and closing, structuring and restructuring, naming and renaming, and autonomous spin-offs of some of the CSIR's research and development activities since its inception in 1945.

1945	• The Council for Scientific and Industrial Research is formally established on 5 October 1945 as a body corporate in terms of the Scientific Research Council Act, 1945 (Act 33 of 1945), of the Parliament of the Union of South Africa.
1946	• The CSIR establishes the National Physical Laboratory and National Building Research Institute and scientific liaison offices in London, United Kingdom; and Washington, United States of America. • The CSIR establishes three industrial research institutes under a research association scheme with industry, namely the Fishing Industry Research Institute, Leather Industries Research Institute and South African Paint Research Institute.
1947	• The CSIR establishes the National Chemical Research Laboratory in Pretoria and the Telecommunications Research Laboratory in Johannesburg.
1948	• The CSIR establishes the National Institute for Personnel Research in Johannesburg.
1949	• The CSIR establishes the Sugar Milling Research Institute under a research association scheme with industry.
1950	• The CSIR establishes the Scientific Council for Africa South of the Sahara and the Bituminous Binder Research Unit.
1954	• The CSIR establishes the National Nutrition Research Institute.
1955	• The CSIR Telecommunications Research Laboratory becomes the National Institute of Telecommunications Research. • The CSIR establishes the National Institute for Road Research and National Mechanical Engineering Research Institute.
1956	• The South African Bureau of Standards (SABS) amalgamates with the CSIR.
1957	• The CSIR opens overseas scientific liaison offices in West Germany, in Bonn and Cologne.
1958	• The CSIR establishes the National Institute for Water Research.
1960	• The CSIR establishes the Timber Research Unit and Air Pollution Research Group.
1961	• The CSIR establishes the National Research Institute for Mathematical Sciences, Radio Space Research Station and Microbiology Research Group. • The CSIR inaugurates Hartebeesthoek, the site that the United States National Aeronautics and Space Administration (NASA) identified locally as ideal for a satellite tracking station, as the South African Radio Space Research Station, which it managed under contract to NASA.
1962	• The SABS and CSIR become separate institutions again. • The CSIR forms the Corrosion Group and Sorghum Beer Research Unit and establishes the South African Inventions Development Corporation.
1963	• The CSIR establishes the National Institute for Rocket Research and Development.
1964	• The Republic Observatory, South African Wool and Textile Institute and Government Mechanical Laboratory are incorporated into the CSIR.
1965	• The CSIR establishes the National Institute for Defence Research, incorporating the National Institute for Rocket Research and Development.
1968	• The CSIR opens a scientific liaison office in Paris, France.

NASA (the United States space agency) took over management of the US Vanguard satellite project in 1959, including its global Minitrack network. The radio tracking stations in the network (located at Hartebeesthoek in South Africa and managed by the CSIR under contract to NASA) used radio interferometers and Yagi antennas to obtain orbital data on satellites whose orbits did not incline more than 45 degrees. The Yagi antennas, similar to the one illustrated here at Hartebeesthoek in the early 1960s, were installed at the Minitrack stations as precursors to the large, second-generation antennas that did not require interferometers, similar to the 12 m antenna visible behind the Yagi antenna. The 12 m steerable, parabolic data acquisition antenna was installed at Hartebeesthoek towards the end of 1963. By that time, NASA officials were using the name Space Tracking and Data Acquisition Network (STADAN) for its expanded, updated satellite network and the Minitrack stations were all renamed as STADANs. The Minitrack at Hartebeeshoek became known as the Joburg STADAN.

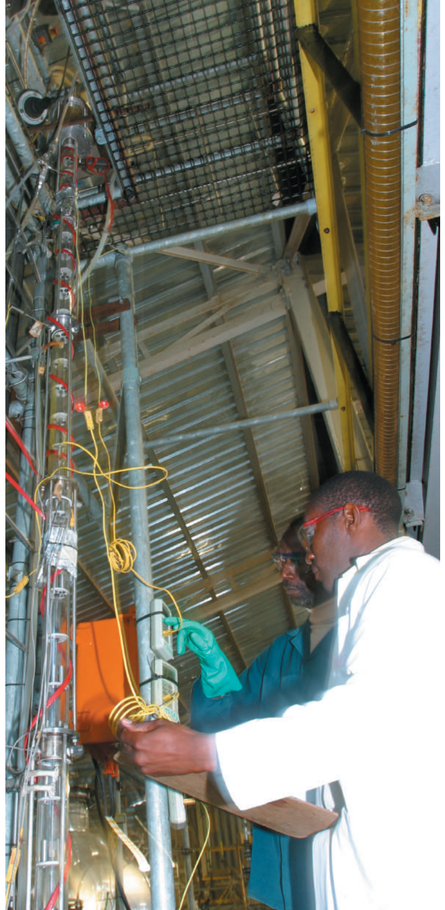
1969	• The Medical Research Council incorporates the CSIR's medical research activities and the CSIR establishes the National Food Research Institute.
1971	• The CSIR establishes the National Electrical Engineering Research Institute.
1972	• The CSIR establishes the South African Astronomical Observatory, located in Sutherland in the Northern Cape.
1973	• The Chemical Engineering Research Group becomes an independent entity, separate from the National Chemical Research Institute.
1974	• The CSIR establishes the National Research Institute for Oceanology.
1975	• The CSIR establishes a scientific liaison office in Tehran, Iran. • The Magnetic Observatory in the (now) Western Cape is incorporated into the CSIR as part of its Science Cooperation Division (later renamed as Cooperative Scientific Programmes). • NASA closes the Joburg Satellite Tracking and Data Acquisition Network and the Deep Space Station at Hartebeesthoek, both of which were manned and managed by the CSIR on behalf of NASA.
1976	• The CSIR renames the National Institute for Road Research as the National Institute for Transport and Road Research and the Timber Research Unit as the National Timber Research Institute.
1977	• The CSIR establishes the National Accelerator Centre.
1978	• The CSIR establishes the National Institute for Aeronautics and Systems Technology.
1980	• The CSIR establishes a National Calibration Centre within the National Physical Research Laboratory. • The CSIR establishes a scientific liaison office in Los Angeles, United States of America.
1983	• The CSIR establishes a Laboratory for Molecular and Cell Biology and the National Institute for Materials Research.
1984	• The Fuel Research Institute is incorporated into the CSIR in terms of an Act of Parliament and renamed the National Institute for Coal Research. • The CSIR combines its Research Grants Division and Cooperative Scientific Programmes into the CSIR Foundation for Research Development.
1985	• The CSIR Personnel Research Institute is transferred to the Human Sciences Research Council.
1986	• The Chemical Engineering Research group becomes the National Institute for Chemical Engineering Research.
1988	• The CSIR operationalises its new 1986 structure as 12 divisions and one centre from 27 institutes: Aeronautical Systems Technology, Building Technology; Earth, Marine and Atmospheric Science and Technology; Energy Technology; Food Science and Technology; Information Services; Materials Science and Technology; Microelectronics and Communications Technology; Processing and Chemical Manufacturing and Technology; Production Technology; Roads and Transport Technology; Water Technology; and the Centre for Advanced Computing and Decision Support. • The Satellite Remote Sensing Centre at Hartebeesthoek is renamed the CSIR Satellite Applications Centre.
1989	• The CSIR transfers its overseas scientific liaison offices from its Foundation for Research Development to its Research Development and Innovation group and the Magnetic Observatory to the Foundation for Research Development and consolidates all its Western Cape activities in Stellenbosch. • The CSIR closes the Institute for Telecommunications Research, Pretoria cyclotron and the regional offices of the Division of Building Technology and privatises the Applied Chemistry Unit, Mechanical Design Office and Transport Services, while the Laboratory for Molecular Cell Biology is taken over by industry.
1990	• The CSIR establishes the Division of Textile Technologies in Port Elizabeth (now called Gqeberha), while the staff of the South African Forestry Research Institute join the CSIR. • The CSIR Foundation for Research Development becomes an independent council.
1991	• The Magnetic Observatory is transferred back to the CSIR. • The CSIR transfers the national facilities – National Accelerator Centre, South African Astronomical Observatory and Radio Astronomy Observatory – to the Foundation for Research Development.
1992	• The CSIR establishes a Division of Manufacturing and Aeronautical Systems Technology from previous Aeronautical Systems Technology and Production Technology Divisions.
1993	• The Chamber of Mines Research Organisation merges with the CSIR to form the Division of Mining Technology. • The CSIR closes its remaining overseas liaison offices and establishes an International Relations Unit in Pretoria. • The CSIR is listed as a public entity, effective on 1 April 1993, in terms of the reporting by Public Entities Act, (Act 93 of 1992).



A scale-model demonstration of a methane ignition in an underground coal mine. Understanding and managing the ever-present risk of methane gas ignition in coal mines are critical to worker safety. This is one of the focus areas of the fires and explosion testing and training facility at Kloppersbos in Gauteng, which became operational in 1987. In 1993, the Chamber of Mines Research Organisation merged with the CSIR to form the Division of Mining Technology. Shortly thereafter the facility became part of this division and today continues with this specialised support as part of CSIR Future Production: Mining.

1994	• The South African National Calibration Service becomes an independent body. • The CSIR closes and deploys the activities of its Division of Energy Technology among its other divisions.
1995	• The Fishing Industries Research Institute merges with the Division of Food Science and Technology. • The CSIR consolidates the Divisions of Earth, Marine and Atmospheric Sciences and Technology, Forest Science and Technology, Water Technology and Corporate Environmental Services into a new Division of Water, Environment and Forestry.
1997	• MIH Holdings, the sister company of M-Net, enters the Internet industry following the acquisition of CompuServe Africa and Worldnet Africa from the CSIR. The Internet was in its infancy when the CSIR first got involved and developed the country's first Internet Service Provider. A core group of CSIR staff moved from the CSIR to MIH Holdings.
1998	• The CSIR launches its CSIR Innovation Leadership and Learning Academy to operate as a virtual human resources development mechanism to meet internal and external training needs.
1999	• The AECI's research and development facilities at Modderfontein in Johannesburg merge with the CSIR, bringing on board staff and equipment in biotechnology, computational chemistry, chemical process technology and fine chemicals. • The CSIR establishes Technovent (Pty) Ltd as a technology ventures company to acquire and incubate proven technologies into commercially viable enterprises.
2000	• The Department of Arts, Culture, Science and Technology facilitates the merging of the CSIR and the South African Nuclear Energy Corporation as a National Laser Centre (NLC) to increase the use of laser technology within industry locally. • A partnership between the Gauteng Provincial Government and a CSIR/University of Pretoria alliance (branded as the Southern Education and Research Alliance) forms the foundation for The Innovation Hub, created to stimulate innovation and economic growth in Gauteng. • The CSIR establishes a National Product Development Centre as a single contact point for design and manufacturing businesses and to assist in positioning their products globally. • The CSIR coordinates the establishment of the Automotive Industry Development Centre to provide accessible and affordable world-class technical and project-focused resources to the local and international automotive industry.
2001	• The CSIR acquires the research and development function of Mechem, a commercial clearance company in the security industry, to establish a technology base in mine detection and clearance and enhance clearance operations in partnership with commercial entities. • The African Centre for Gene Technologies is established by the Southern Education and Research Alliance, and rapidly makes advances in equipping itself for a role in gene and genome analysis and their applications. A proteomics facility, a structural modelling facility and a DNA microarray facility were established under its auspices.
2002	• The CSIR strengthens its resources to participate fully in the newly launched New Partnership for Africa's Development (NEPAD), ratified as the strategic programme for the African Union. • The nerve centre of the newly established Global Research Alliance, with nine member institutions from five continents, is based at the CSIR. • The African Laser Centre is formed to support research collaboration between researchers in South Africa and the rest of the African continent in the emerging field of laser technology. • The CSIR becomes the official host of the National Cleaner Production Centre of South Africa (NCPC-SA) for the then Department of Trade and Industry. The NCPC-SA promotes resource efficiency and cleaner production methodologies to lower the costs of using energy, water and materials and managing industrial waste.
2003	• The CSIR establishes a Cultural/Craft Industries Design Unit to lead cultural industry design nationally and internationally through uniquely South African poverty alleviation projects funded by the then Department of Science and Technology.
2004	• The CSIR launches the Beyond 60 process to better serve the country's needs with a stronger science and technology capability. A new structure results from the process, featuring five research and development units, namely Defence, Peace, Safety and Security; Built Environment; Biosciences; Materials Science and Manufacturing; and Natural Resources and the Environment. The CSIR's national research centres continue with their core functions, including the Satellite Applications Centre, NLC and National Metrology Laboratory. CSIR Knowledge Services provides specialised services to industry, while CSIR Shared Services supports the organisation internally.

The AECI's research and development facilities became part of the CSIR's chemistry and biochemistry infrastructure in 1999.



2005	• The CSIR Meraka Institute is launched at the CSIR International Convention Centre on World Telecommunications Day. The institute is regarded as a significant intervention in information and communications technology locally. • The Southern Africa Network for Biosciences is established as one of five NEPAD networks to share biosciences research, development and innovation in health and nutrition for southern Africa and is hosted at the CSIR.
2006	• The CSIR becomes the host of the Aerospace Industry Support Initiative (AISI) on behalf of the then Department of Trade and Industry. AISI is dedicated to improving the competitiveness of the local aeronautics, space, defence and marine advanced manufacturing sectors. • The first CSIR Conference, open to all stakeholders and the public, is held in February 2006 to portray the full multidisciplinary scientific diversity of the organisation. The CSIR hosts the conference again in 2008, 2010, 2012, 2015, 2017 and online in 2021.
2007	• With the promulgation of the new Measurement Units and Measurement Standards Act, 2006 (Act 18 of 2006), the CSIR National Metrology Laboratory is established as the National Metrology Institute of South Africa, a separate public entity. This new public entity becomes part of the former Department of Trade and Industry's technical infrastructure family. • The CSIR establishes a Modelling and Digital Science unit. • The Centre for High Performance Computing is established to provide high-performance computing resources and domain-specific support to public and private sector users.
2008	• Following a review, CSIR Knowledge Services, with its requirements for close market interaction, becomes CSIR Consulting and Analytical Services.
2010	• The CSIR Satellite Applications Centre celebrates its 50th anniversary and is incorporated into the South African National Space Agency, which is launched on 9 December 2010.
2012	• Cabinet approves the CSIR's Growth and Impact Strategy, which is informed by national priorities, the National Development Plan and the Millennium Development Goals. Organisational activities are structured into six research impact areas, namely the built environment; defence and security; energy; health; the natural environment; and industry, which are supported by the core technologies of information and communications technology, sensors, modelling, photonics, materials and robotics.
2014	• The CSIR initiates a flagship programme for large integrated, impact-driven development and innovation initiatives to achieve clear objectives and outcomes within a set time. The first three flagship programmes focus on water sustainability, health and nutrition, and safety and security.
2016	• The CSIR establishes a mining research and development hub to modernise mining through optimisation, innovation, mechanisation and automation. • The National Integrated Cyber Infrastructure System is formed to promote scientific and industrial development through the provision of high-performance computing capability, high-speed network capacity and a national research data infrastructure.
2018	• The Mining Research and Development hub established in 2016 is launched as the Mandela Mining Precinct. It remains a hub-and-spoke model funded by the then Department of Science and Technology and the Minerals Council South Africa to implement the South African Mining Extraction, Research, Development and Innovation strategy.
2019	• The CSIR Board approves a new CSIR strategy to achieve greater impact in industry and to invigorate competitiveness in a struggling economy. The revised structure entails nine technology sector clusters and supporting initiatives, namely six industry advancement clusters, Advanced Agriculture and Food; Defence and Security; Future Production: Chemicals; Future Production: Manufacturing; Future Production: Mining; and NextGen Health and three industry and society enabling clusters, Smart Mobility, Smart Places, and NextGen Enterprises and Institutions.
2020	• The CSIR assumes its role as host of South Africa's Centre for the Fourth Industrial Revolution (C4IR South Africa). The centre is a platform for public and private stakeholders to collaborate on developing frameworks and guidelines for the adoption of fourth industrial revolution technologies.

The Centre for High Performance Computing was established in 2007 to provide high-performance computing resources and domain-specific support to public and private sector users. Today it forms part of a bigger initiative, the National Integrated Cyber Infrastructure System, which was formed to promote scientific and industrial development through the provision of high-performance computing capability, high-speed network capacity and a national research data infrastructure.

SHAREHOLDING – MANDATED OVERSIGHT

CABINET MINISTERS THROUGH WHOM THE CSIR REPORTED TO PARLIAMENT

The council is "… a corporate body, outside the Government Service … It is, however, responsible to Parliament, through the Prime Minister, for its programme and its estimates."
(Objects and Policy of the South African Council for Scientific and Industrial Research – an Initial Statement, Council for Scientific and Industrial Research, Pretoria 1945, p. 5.)

"18. The State President may by proclamation in the Gazette assign the administration of this Act to any Minister … " (The Scientific Research Council Act, 1962 (Act 32 of 1962), as amended)

Since 1945, numerous South African Cabinet Ministers, responsible for different government departments, have held the responsibility of the administration of the Scientific Research Council Act. It was only in 2002 that South Africa, for the first time in its history, dedicated a department to science and technology matters. The Department of Science and Technology was formed in August 2002, at which stage a process for the transfer of the CSIR from the **Department of Trade and Industry** to the **Department of Science and Technology** was initiated. This transfer was in keeping with the institutional alignment arrangements outlined in the National Research and Development Strategy.

In April 2004, President Thabo Mbeki announced a separate Ministry for Science and Technology and, in 2005, the President approved and gazetted the transfer of the governance and budget of the CSIR to the Department of Science and Technology, effective from 1 April 2005.

Before the formation of a science and technology department, the CSIR had a long and productive association with the Department of Trade and Industry, whose Minister has been assigned the responsibility of administering the Scientific Research Council Act. This relationship continued even after the country's Department of Arts, Culture, Science and Technology (DACST) had been formed under President Nelson Mandela, as part of the new ANC-led government in 1994. The CSIR also had a close relationship with DACST, which managed the country's Science Vote process, through which parliamentary grant funding across the science and technology base of South Africa was distributed.

Today the CSIR reports to Dr Blade Nzimande, Minister of Higher Education, Science and Innovation.

1945-1947	Gen. J C Smuts, Prime Minister of the Union of South Africa
1948-1950	Dr D F Malan, Prime Minister of the Union of South Africa
1951-1954	Dr E H Louw, Minister of Economic Affairs
1955-1958	Dr A J R van Rhijn, Minister of Economic Affairs
1959-1963	Dr N J Diederichs, Minister of Economic Affairs
1964-1965	Adv. J F W Haak, Minister of Planning
1966-1969	Dr C de Wet, Minister of Planning
1970-1971	J J Loots, Minister of Planning
1972-1974	J J Loots, Minister of Planning and the Environment
1975-1977	Dr S W van der Merwe, Minister of Planning and the Environment
1978	J C Heunis, Minister of Economic Affairs, Environmental Planning and Energy
1979	Dr S W van der Merwe, Minister of Industries, Commerce and Consumer Affairs
1980	F W de Klerk, Minister of Mining and Environmental Planning and Energy
1981-1986	Dr D J de Villiers, Minister of Industries, Commerce and Tourism
1987-1988	D W Steyn, Minster of Economic Affairs and Technology
1989-1991	P Clase, Minister of Education and Culture
1991-1993	D L Keys, Minister of Economic Coordination and Trade and Industry
1994-1996	Trevor Manuel, Minister of Trade and Industry
1996-2004	A Erwin, Minister of Trade and Industry
2004	M M B Mphahlwa, Minister of Trade and Industry
2005-2009	Dr A M Mangena, Minister of Science and Technology
2009-2012	Dr G N M Pandor, Minister of Science and Technology
2012-2014	D A Hanekom, Minister of Science and Technology
2014-2018	Dr G N M Pandor, Minister of Science and Technology
2018-2019	M T Kubayi-Ngubane, Minister of Science and Technology
2019 to date	Dr B E Nzimande, Minister of Higher Education, Science and Innovation

ENRICHING CONNECTIONS – VISITORS FROM FAR AND NEAR

"If you want visitors then you leave your front door open." – African proverb

Organisations grow and benefit from outsider thinking, perceptions and knowledge. Visitor interactions stimulate interests, enrich ideas and often help to shape innovative thinking and direct inventive action.

Engaging with visitors can offer lasting cooperation and the meaningful exchange of ideas, concepts and theories to enhance, sustain and combine achievements. The CSIR has hosted many illustrious and high-profile visitors at its Scientia site in Pretoria and at its regional offices across the country. Interaction and discussions with acclaimed thought leaders and representatives from local and international peer and stakeholder organisations to share knowledge, expertise and wisdom added richly to our own insights, perspectives and expertise. We look forward to continued benefit from these enriching connections in the years ahead.

The montage of visitors on these pages brings to life a small selection of those hosted at the CSIR during the past 75 years.

Dr Thulani Dlamini, CSIR Chief Executive Officer, with the governor of the Zhejiang province in China, Premier Yuan Jiajun, at the signing of a cooperation agreement in 2021.

VISITS BY SOUTH AFRICAN PRESIDENTS AND DEPUTY PRESIDENTS

CSIR Chairperson Paul Kruger and CSIR President Dr Brian Clark host a visit by a delegation of the African National Congress (ANC), led by ANC President Dr Nelson Mandela. Mandela became the first democratically elected President of South Africa in 1994.

1991

2001

President Thabo Mbeki visits a project that brought information and communications technology and its benefits to the community of Tsilitwa in the Eastern Cape. He was welcomed by the CSIR's Ajay Makan, Chris Morris and SJ Jacobs.

President Thabo Mbeki visits the CSIR for a demonstration of how CSIR research improves the quality of life of South Africans. The Meraka Institute's Dr Quentin Williams and Willem van der Walt (seated) demonstrate how visually impaired individuals can benefit from information and communications technology that uses built-in speech technologies.

2007

2015

President Jaco Zuma visits the Transnet Laboratory, part of a joint research and development centre at the CSIR campus. The CSIR and Transnet formed a strategic partnership in 2013 to focus on localised manufacturing and optimised logistics efficiency.

Deputy President Cyril Ramaphosa visits the CSIR as board chairperson of the Human Resources Development Council. CSIR Chief Executive Officer Dr Thulani Dlamini accompanied the Deputy President to the Nanomaterials Industry Development Facility where they were welcomed by CSIR chief researcher and the director of the facility, Prof. Suprakas Sinha Ray and young researchers ready to demonstrate their projects.

2017

2020

President Cyril Ramaphosa visits the Covid-19 Information Centre, a data centre set up to monitor and track the local spread of the coronavirus disease. Housed in a secure facility at the CSIR, the centre provides close to real-time analytics and dashboards on disease outbreaks per province, district, local municipality and ward.

A SELECTION OF VISITS BY SOUTH AFRICAN CABINET MINISTERS

Visits and engagements with some of the post-1994 South African Cabinet Ministers assigned administrative responsibility for the CSIR by the Scientific Research Council Act, 1962 (Act 32 of 1962).

Minister of Trade and Industry Alec Erwin and CSIR Chief Executive Officer Dr Sibusiso Sibisi.

2002

2004

CSIR Chief Executive Officer Dr Sibusiso Sibisi welcomes Minister of Science and Technology Dr Mosibudi Mangena during his first official visit to the CSIR.

Minister of Science and Technology Dr Naledi Pandor receives an image acquired over East London in the Eastern Cape by the South African manufactured satellite, SumbandilaSat, from CSIR Satellite Applications Centre Manager Raoul Hodges. The CSIR Satellite Applications Centre downloaded images from the satellite using its Hartebeesthoek-based antennas.

2010

2013

Science and Technology Minister Derek Hanekom (left) with Imraan Patel, now Deputy Director-General at the Department of Science and Innovation, and the CSIR's Lee Annamalai (right) at an open day hosted by the CSIR Meraka Institute in 2013.

Minister of Science and Technology Dr Naledi Pandor flanked by then Deputy President Cyril Ramaphosa and CSIR Board Chairperson Prof. Thokozani Majozi, at the CSIR Conference in 2015. Left are CSIR principal researcher Dr Bruce Sithole and CSIR Chief Executive Officer Dr Sibusiso Sibisi, with (right) Dr Pat Manders, Manager of the CSIR National Laser Centre at the time.

2015

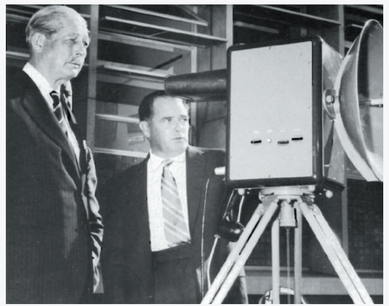
2018

Minister of Science and Technology Mmamoloko Kubayi-Ngubane learns more about an autonomous vehicle during a demonstration by Dr Tleyane Sono, the manager for landward sciences at the CSIR.

MORE ILLUSTRIOUS VISITS AND ENGAGEMENTS

The CSIR's Dr Trevor Wadley demonstrates the tellurometer distance measuring system to British Prime Minister Sir Harold MacMillan during the latter's historical visit to South Africa in 1960. In his "Winds of Change" speech of February 1960, MacMillan confirmed Britain's support for majority rule in Africa.

1960



1985

The CSIR hosts reporters from the British Broadcasting Corporation (BBC) during a 10-day visit to South Africa to compile material for several science documentaries. From left are Kevin Napier and Ken Finlayson from the CSIR; Colin Tudge, BBC presenter, and Alison Richards, senior producer at the BBC Science Unit.

Dame Margaret Thatcher, former British Prime Minister, meets CSIR President Dr Brian Clark and members of the CSIR Executive team at the CSIR Conference Centre.

1992

2001

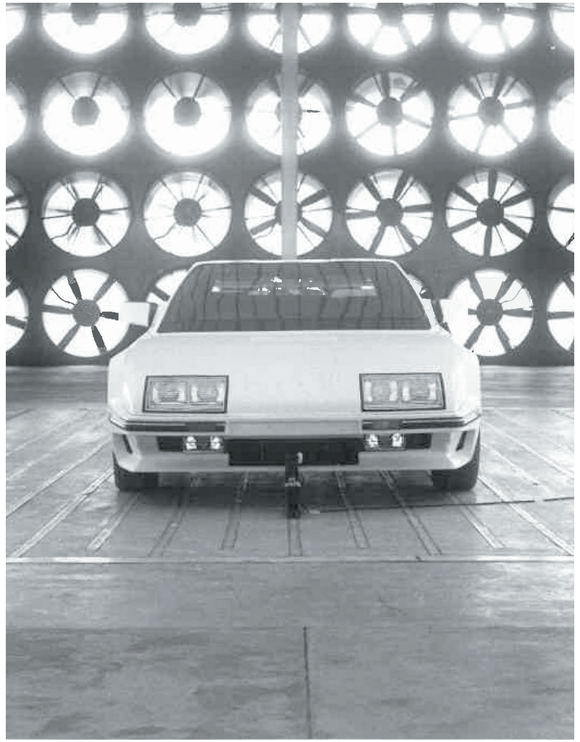
Manager of the CSIR Satellite Applications Centre Renier Balt welcomes French Prime Minister Lionel Jospin during an official two-day visit to South Africa. French-South African cooperation in space-related matters included telemetry, tracking and command support of more than a hundred French satellite launches at the time, mostly for the French National Space Agency, CNES, as well as the reception of satellite imagery from the French SPOT satellites since 1989.

The CSIR Satellite Applications Centre tracked the space flight carrying the first South African to space, global leader in open source and venture philanthropy and benefactor of the Shuttleworth Foundation, Mark Shuttleworth. Present during the handing over of a framed photo of the antenna with which the CSIR team tracked Shuttleworth's space flight, were, from left, Patrick Buso of the CSIR, CSIR Chief Executive Officer Dr Sibusiso Sibisi, Mark Shuttleworth, President Thabo Mbeki and the CSIR's Piet van der Westhuizen.

2002

2006

CSIR Chief Executive Officer Dr Sibusiso Sibisi with multiple Emmy and Golden Globe winner and recipient of the Officer of the British Empire (OBE), Jane Seymour and acclaimed producer Jim Thebaut at the screening of the *Running Dry* documentary at the CSIR. The documentary, written, produced and directed by Thebaut and narrated by Seymour, debuted in South Africa during the screening at the CSIR to raise awareness about the worsening global humanitarian water crisis.



THEN AND NOW

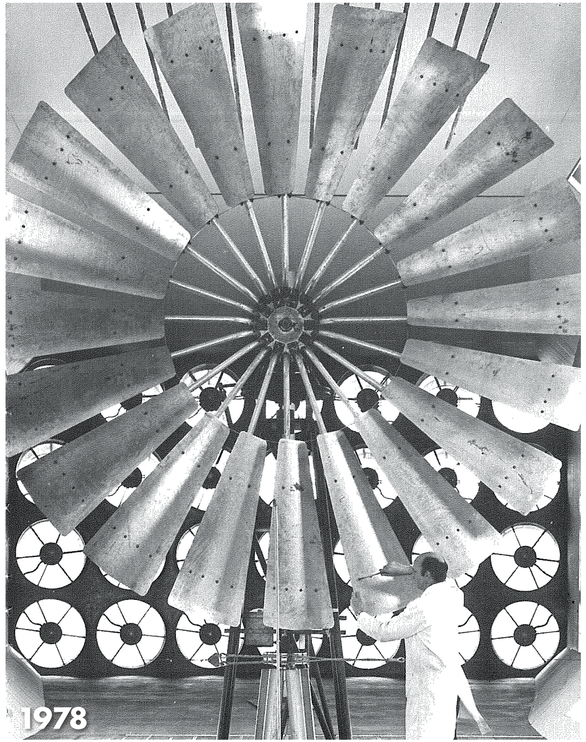
Now and then it is good to pause, to hang a question mark on the things we take for granted. Now and then, we should step aside, relook where we were and take pride in how far we have come. And then, emboldened, we can step ahead again, for it is when we keep going, that we make the most progress.

The following pages offer a visual 'then-and-now' perspective on how scientists, engineers and technologists applied knowledge, skills and expertise in their areas of specialisation with cutting-edge equipment and infrastructure at the time, and how technological advances enable them to pursue those scientific endeavours today. The 'then' images remind us of a world in which the options to communicate, relay information and even present information, were limited. The 'now' images illustrate how the CSIR's state-of-the-art equipment today keeps the organisation at the forefront of research and innovation to help solve some of our greatest challenges.

AERODYNAMICS

1978: A wind turbine tested in the 7 m wind tunnel, as featured in the 1978 CSIR annual report. The facility was established to meet the research needs in aeromechanics. In addition to its use in aeronautics, the facility was invaluable in studying the effects of wind forces. The 7 m wind tunnel has also seen its fair share of high-speed vehicles over the years, since aerodynamics plays a key part in high-speed racing and driving. The bodywork of numerous sports cars, such as the one left, has been aerodynamically tested at the CSIR.

2018: More than 40 years later, the objects being tested are somewhat more advanced, but the 7 m wind tunnel facility continues to be of significant value to industry. In 2018, the CSIR tested the transparent wing of a new turbine for its inventor, Robert Bray, who wants to make renewable energy generation in cities a reality. The wing has the ability to reverse lift from one surface to another, instantaneously. The wings have transparent surfaces for low visual impact.

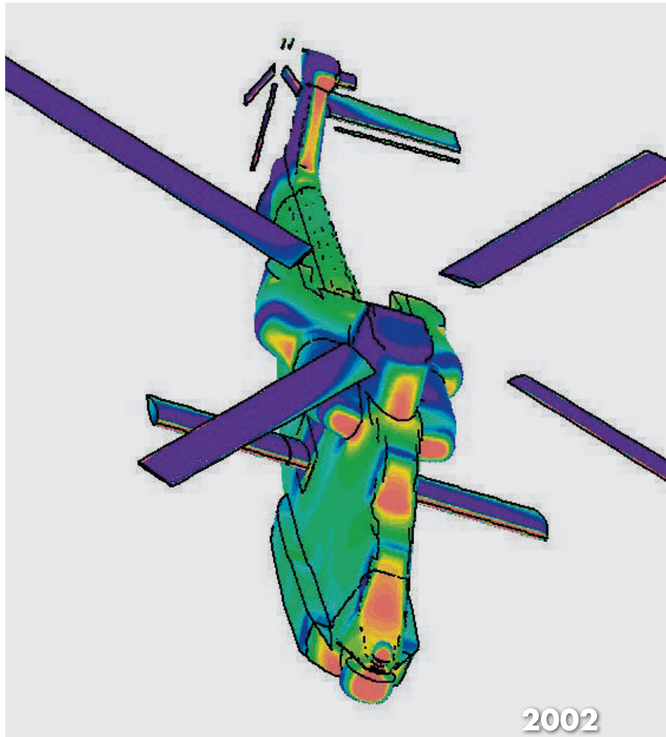


AERONAUTICS

1973: An experimental prototype two-seater autogyro, built by the CSIR's aeronautics research unit after its establishment in 1968, is flown successfully. At the time, the CSIR foresaw the unit as a research and development centre for the emerging aircraft manufacturing industry in South Africa. The CSIR also developed design and manufacturing techniques for helicopter main and tail rotor blades in glass and carbon fibre reinforced composite material. This improved the structural performance of the blades significantly at a cost lower than imported metal blades.

1990: From these early beginnings, the CSIR further developed the wind tunnel infrastructure, while CSIR researchers developed the skills – including skills on controls, infrared suppressors, armament solutions, structures and engines technology – to contribute to the survivability of the Rooivalk Attack Helicopter. The helicopter entered service for Denel Aviation in 1999 and the research led to the creation of a local aerospace composites industry. Researchers used the Rooivalk model (centre) in the wind tunnel to test its aerodynamics.

2002: CSIR researchers used computational fluid dynamics to study the Rooivalk's aerodynamics for a system upgrade (far right).

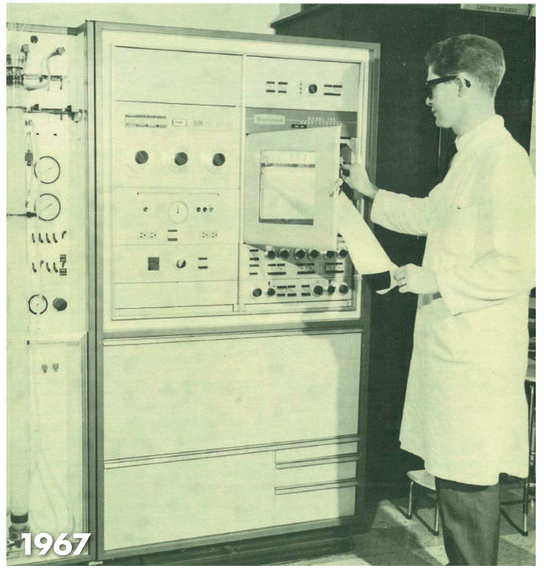


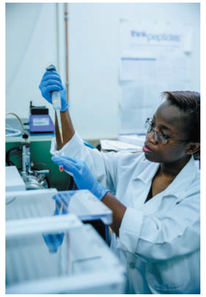
MICROSCOPY

Circa 1966: Dr J J Theron, Director of the CSIR's National Nutrition Research Institute and leader of a team of scientists doing research on oesophagus and liver cancer, using an electronmicroscope acquired for this purpose.

The discovery in the 1960s that the *Aspergillus flavus* mould found on legumes and grain was extremely poisonous, as well as carcinogenic, sparked an intensive study of toxin-forming fungi on foodstuffs. The CSIR was well-placed to contribute effectively to identifying toxin-bearing fungal strains, with the National Chemical Research Laboratory isolating and identifying the toxic components and working out analytical techniques, and the National Nutrition Research Institute determining the toxicity of the substances and studying their role in the development of cancer.

2020: Dr Janine Scholefield leads a team of CSIR experts in bioengineering and integrated genomics that has succeeded in generating microlivers from induced pluripotent stem cell-derived cells from individuals of African descent. The researchers are growing these tiny artificial livers in petri dishes to replace human and animal subjects for drug-safety testing. The induced pluripotent stem cells are a cutting-edge, ethically acceptable type of stem cell that is not extracted from human embryos. This milestone is a significant breakthrough in providing information for the best treatment outcomes for high-impact diseases, such as tuberculosis, HIV/Aids and cancer in South Africa. The team uses a technique in which a specific DNA sequence can be precisely modified inside a cell to add important African mutations that contribute, uniquely and significantly, to adverse drug reactions in South Africa.





CHROMATOGRAPHY

Chromatography, a process for separating components of a mixture, is as valuable in science today as it was more than a hundred years ago when it was first taken up by scientists. The technology has advanced dramatically in terms of speed, accuracy and automation.

1967: The CSIR National Chemical Research Laboratory used a Spectrochrom, an automatic device for the chromatography of wool proteins, in research for the South African Wool Textile Research Institute. The research included aspects such as refining wool grease.

2019: The structure of a protein determines its function. This simple, but crucial, fact is fundamental to research into communicable and non-communicable diseases, such as HIV and cancer, which the CSIR's core proteomics facility supports. The facility houses liquid chromatography mass spectrometry systems, such as this one operated by Dr Sindisiwe Buthelezi, that can separate incredibly complex samples into individual protein components and measure their abundance across healthy and diseased states. This can highlight the mechanisms of action behind various disorders, as well as identify reporter proteins. These proteins change upon disease onset and progression, and can be at the core of novel, more precise, omics-based diagnostic tools.

A CAMPUS WITH AND WITHOUT SOLAR PHOTOVOLTAICS

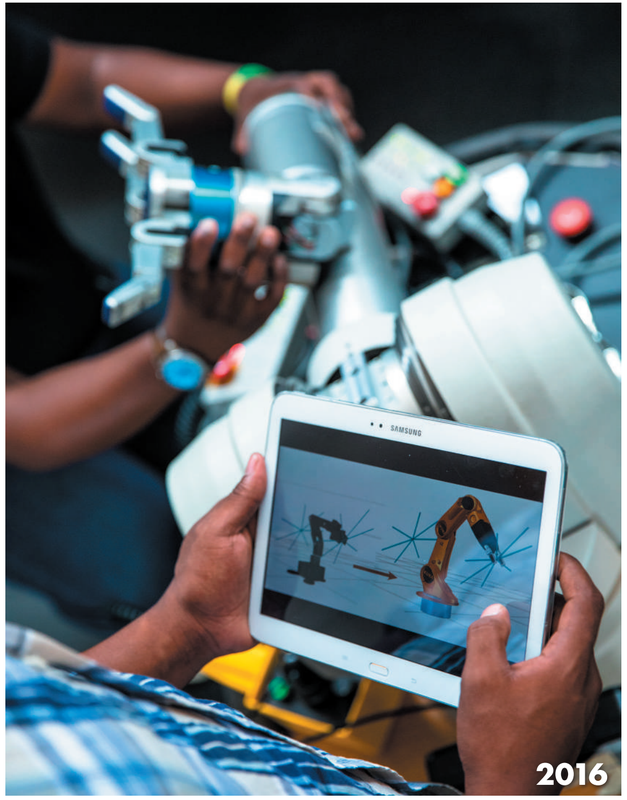
1962: State President C R Swart unveiled a commemorative plaque at the CSIR on 9 August 1962, when he officially dedicated the CSIR laboratories and facilities to the advancement of science in South Africa. The CSIR skyline remained unchanged and familiar for many years.

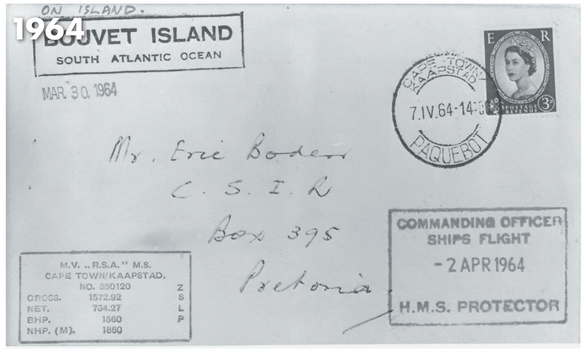
2018: With an approximate energy use of 30 gigawatt hours per year, the CSIR's Scientia campus in Pretoria today benefits from renewable energy technology from the three solar photovoltaic plants installed between 2015 and 2018. Many of the panels are out of sight on building rooftops, while one stretch of solar panels lines the most northern part of the campus adjacent to the highway.

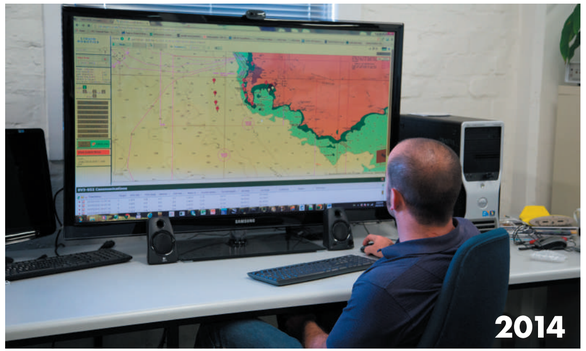
ROBOTICS

1985: The CSIR's National Electrical Engineering Research Institute developed a unique robot gripper. It had two degrees of freedom and was equipped with force, position and velocity sensors. A special micro-computer processed the sensory information and made logical decisions about the operation of the gripper.

2016: Robotics is now well-developed and the focus is on designing and developing intelligent robots that operate in real-world environments, unlike conventional robots that operate in controlled environments. Advances in sensor technology, for example, mean that an operator can demonstrate a task to a robot through visual sensors, creating a need for learning-based computer programming.



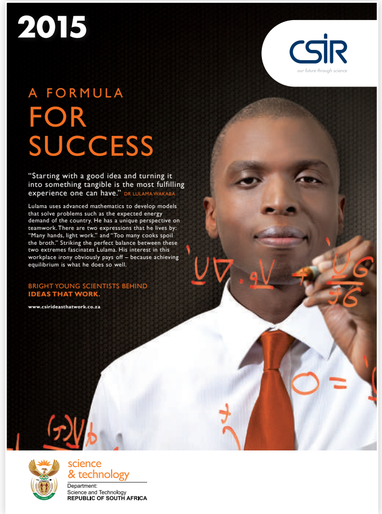


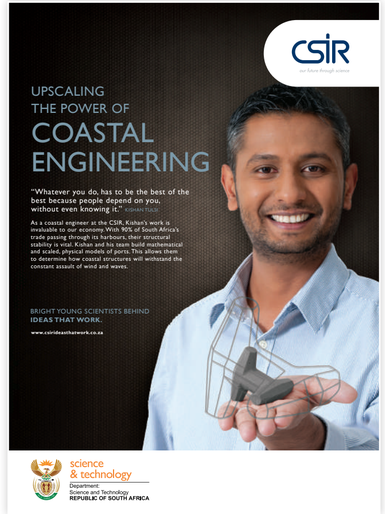


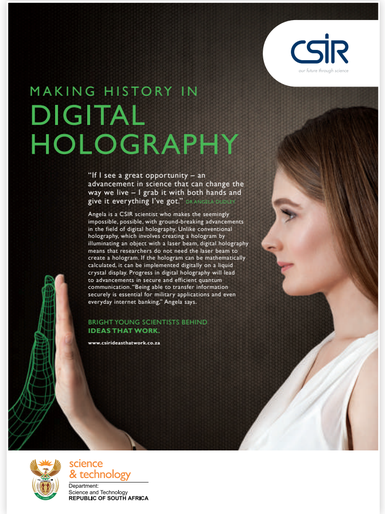
OCEANIC RESEARCH: INFORMATION TO AND FROM THE ANTARCTIC

1964: The story of this envelope and its journey from Bouvet Island in the South Atlantic Ocean to Pretoria in South Africa in the 1960s reminds us how limited communication options were at the time while on a research mission in the Antarctic. The envelope contained a letter written on board the South African research ship, RSA, by Antarctic geologist D C Neethling, to Eric Boden, Head of the CSIR's Science Cooperation Division. Neethling addressed the envelope when the RSA was 53 degrees south, 4 degrees east during her voyage to Bouvet Island. The mail was flown by helicopter from the RSA to the island, then flown to the Royal Navy's ice patrol ship, HMS Protector, which had rendezvoused with the RSA off Bouvet Island. The HMS Protector delivered the letter to Cape Town from where it was flown to Pretoria.

2014: The communication and technology options of CSIR researchers who still form part of Antarctic missions are now vast and advanced. Over the past 10 years, researchers from the Southern Ocean Carbon and Climate Observatory have contributed to a greater understanding and ability to predict the variability and trends of carbon dioxide in the Southern Ocean, which are critical to slowing down global warming and climate change. Researchers now use satellite communications to send and receive data and stay in touch, while also pioneering ocean robotics – deploying wave gliders, such as the one shown here from the SA Agulhas – into the ocean to provide researchers with a continuous flow of measurement data. Glider pilots in Cape Town use satellite communications to steer ocean robots thousands of kilometers away in the remote Southern Ocean.



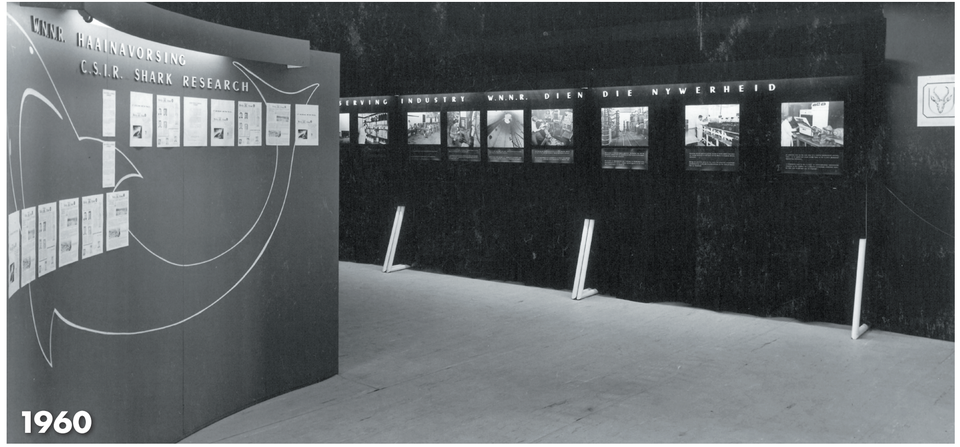




ADVERTISING CAMPAIGNS

1992: The CSIR's 'Just Imagine' corporate advertising campaign – a first for the organisation and among science councils locally – was incorporated in its 1991/92 annual report. The campaign supported the organisation's revised strategy to explore newly available commercialisation opportunities in a South Africa freed from economic sanctions and embargoes in the early 1990s. The campaign gave voice to this renewal, for the country and the CSIR, through its catch phrase of "Just Imagine [what we can do]."

2015: A CSIR mass awareness campaign that started in January 2015 featured adverts on television, radio and print, as well as online media. The "Ideas that work" campaign was extended to feature the people behind the ideas that work.



EXHIBITIONS

The CSIR's desire to share its work has remained constant over the decades, but the technologies available to do so have changed in unimaginable ways.

1960: The Permanent Exhibition of Modern Science was hosted in a hall at the Pretoria Showgrounds. The *South African Journal of Science and Technology* (December 1960, Volume 12), tells the story: "At this stage the Committee was able to consider seriously the possibility of launching the science exhibition in association with the 1960 Pretoria Industrial Show, which would open at the end of August, 1960. ... The first major indications of support came from two Pretoria institutions – the Council for Scientific and Industrial Research (C.S.I.R.) and the Iron and Steel Industrial Corporation (ISCOR). The C.S.I.R. indicated that if the project were to go ahead, it would forego the annual open days for its research laboratories and put an equivalent effort into a display of its research activities as part of the science exhibition".

2015 and 2017: The one-dimensional, monochrome look of exhibitions in the 1960s improved significantly when electronic screens, 3D-printed models and colourful fabric-printed canvases became available, such as those used in the exhibitions at the 2015 and 2017 CSIR Conferences. These modern 21st century exhibitions changed even more dramatically when the Covid-19 pandemic forced companies to communicate digitally with stakeholders and conferences and exhibitions became fully digital. The CSIR 2020 Conference was the organisation's first fully digital conference.

SCIENCE ENGAGEMENT

Reaching out to South Africa's young talent to enliven in them a career interest in science, engineering and technology (SET) has been integral to the CSIR's transformation journey since the early 1990s and remains an important focal point in its developmental agenda.

1995: The CSIR's first Mindwalk competition for scholars was launched as a pilot in Gauteng during the organisation's 50th anniversary celebrations. Immediately successful, the competition was extended in the following years to schools in other provinces.

In 1998, the CSIR welcomed and participated in government's bold initiative of declaring 1998 as the Year of Science and Technology with its 1998 Mindwalk Competition and a science, technology and arts festival at the Scientia campus in Pretoria.

2000 onwards: Outreach initiatives included participation in:

- **National Science Week**, a Department of Science and Innovation (DSI) initiative to create science-based activities for learners (the 2019 National Science Week activities at the CSIR in Pretoria are shown right);
- **Scifest Africa**, the National Science Festival held in Makhanda (formerly Grahamstown) in the Eastern Cape annually;
- **Sasol TechnoX**, a science, maths and technology exhibition, attended by schools in the Free State, with displays, workshops, tours, talks and hands-on activities for learners, students and the general public;
- the **Eding International Science Festival**, known as Eisef, which attracts participants from rural villages in Limpopo and North West;
- **Science Beyond Borders**, a week-long festival that rotates between Limpopo, Mpumalanga and the Northern Cape, with science and technology-based activities;
- **CSIR Career Day**, initiated in 2014 as part of a DSI initiative for SET organisations to interact with the youth and stimulate an interest in SET careers; and
- the **Ministerial Izimbizo,** organised by the DSI to expose young people and the community to careers in science, with practical demonstrations of what science means in daily life.

A CAMPUS WITH A RICH HISTORY

OUR CAMPUS

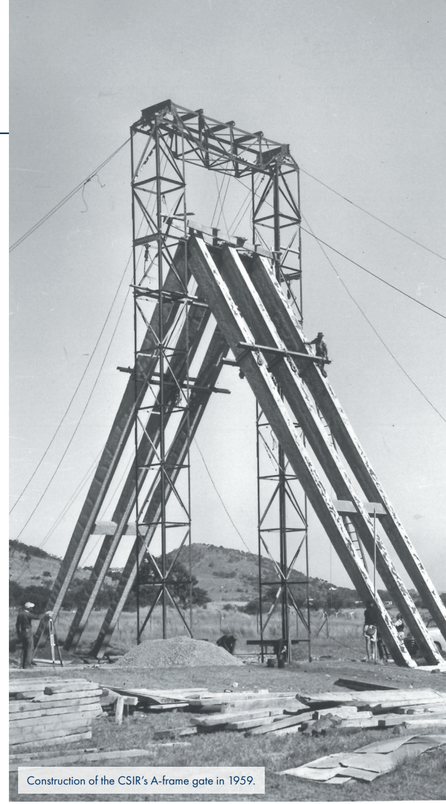
"The common bond in the quest for knowledge among a large group of highly qualified people, many of them exceptionally talented with wide-ranging interests, concentrated on one site, could not but create a unique environment."

– Nicolene Basson in: Passage to Progress, 1996:30

Following its establishment in 1945, the CSIR rented interim accommodation in Pretoria from the Public Works Department in the Visagie Street Munitions Section of the South African Mint, while endeavours were underway to find a suitable site for a permanent home.

In the early 1950s, Sir Basil Schonland's vision of such a home for the CSIR in "a beautiful garden setting ... to create the right atmosphere for researchers to do their creative best" became a reality. Dr Meiring Naudé, CSIR President at the time, secured an undeveloped 100 hectares tract of land to the east of the city as a gift from the University of Pretoria. The park-like setting was home to small indigenous animals and an abundance of bird life and, to this day, it still provides shelter to small buck, geese, guinea fowl and a large variety of bird species. Under Naudé's watchful eye, plans progressed speedily to construct the executive headquarters and national institutes, with priority given to small special-purpose buildings for acoustic research, a cyclotron and a wind tunnel.

The National Physical Laboratory, National Chemical Research Laboratory and National Building Research Institute were the first of the



Construction of the CSIR's A-frame gate in 1959.

An aerial view of a building on the south campus.

Home to the Department of Science and Innovation.

The main entrance of the CSIR International Convention Centre.

national research institutes established on the site. The construction of additional research institutes at the time also included those for mechanical and electrical engineering and defence.

Over the years, the CSIR purchased more land to accommodate new buildings, more modern laboratories and pilot plant facilities. Although surrounded by bustling highways and cityscapes today, the campus still retains a park-like ambiance with its rocky hills, large trees and many open spaces. While many of the buildings are now more than 60 years old, preference given to upgrading and refurbishing laboratories and offices in existing buildings resulted in the construction of relatively few new buildings on the site. The design of new buildings reflects a similar facade as that of the initial buildings to preserve the overall architectural integrity and retain its natural, park-like environment.

The north campus, which lies to the north of the hill that runs through the campus, is home to the main visitors' reception office, the executive building and the organisation's information and communications technology nerve centre. It also features the bulk of the buildings occupied by what was the research institutes in the early years, which are nowadays occupied by staff from the CSIR's clusters. In addition, several modern pilot plants, such as those for biomanufacturing and nanomaterials, are now housed in some of the larger buildings. One of the few newly constructed buildings is the CSIR Knowledge Commons, which provides employees and visitors with spaces for collaboration, learning and knowledge transfer, as well as showcasing CSIR work.

The south campus houses a reception office, the CSIR International Convention Centre, club house and recreation facilities, as well as buildings occupied by cluster staff. It also houses the Entabeni private residency area that offers accommodation to visiting scientists and other local and international visitors.

Today, the Scientia site is **equipped for world-class innovation**. The CSIR recognises that scientific infrastructure is key to scientific discovery and innovation for industry and society. The scientific infrastructure, which includes laboratories, testing facilities, scientific instruments and equipment, clean rooms and pilot plants needed for research and technological innovation, is a national asset and of significant and invaluable benefit to the country.

The nanomaterials industrial development facility.

The CSIR sites in Cape Town, Durban, Johannesburg and Stellenbosch are similarly well-equipped to support world-class research and development.

A CAMPUS EQUIPPED FOR WORLD-CLASS INNOVATION

The medium-speed wind tunnel.

The advanced design and manufacturing innovation centre.

The seven-metre wind tunnel.

A CAMPUS EQUIPPED FOR WORLD-CLASS INNOVATION


Learning factory demonstration platform.


Photonics prototyping facility.


Mechanical testing laboratory.


Proteomics facility.

A CAMPUS FOR ALL

Family Fun Day, 2013.

Career Day, 2007.

CSIR Race, 2014.


Take a Girl Child to Work, 2007.


Inter-unit Squash Tournament, 2012.


Women's Day, 2016.


Soccer World Cup, 2010.


Junior Soccer Tournament, 2012.

OUR BRAND STORY

"Tell the truth, but make the truth fascinating."
– David Ogilvy, brand master extraordinaire

A brand is a promise. It offers an undertaking of the quality, uniqueness and value to be derived from its products and services. Captured in a trademark, it projects an organisation's distinctiveness and uniqueness.

Jealously guarded and built with determination and consistency, the CSIR brand is a 75-year-old icon in the world's science landscape, as relevant and inspirational today as it was in 1945.

During the years leading up to its diamond jubilee in 2020, the CSIR carved a name for itself as a leader in directed and multidisciplinary research. While, over the years, its mandate remained robust, the realities of changing times and shifts in national priorities paved its path along four distinctive epochs – each with a brand image that reflected a change in course.

The journey started from its establishment as a pivotal national scientific powerhouse, to reiterating its close linkages to industry as the technology partner of choice years later. The brand's progression continued with the Beyond 60 process of strengthening the research core, projected as the foundation for excellence. And in 2020, the brand's link to the national interest, the people of South Africa and the organisation's impact on the country's industrial competitiveness became the dominant associations.

During its first 20 years, the organisation used no identifiable icon or logo other than its name on publications and annual reports. The first use of a logo-type image – a microscope, white reversed out of black – appeared on the cover of its 14th annual report in 1959 and never again. Until 1966, for more than 20 years after its establishment, the CSIR brand consisted of a font-based logo that reflected its business name to identify the organisation.

THE CSIR BRAND JOURNEY

1966-1988

Addressing South Africa's technological problems. Serving as a central scientific powerhouse. Advising government on the best methods of developing the country's natural resources. Coordinating scientific research in the national interest.

1988-2006

Transforming to a contract-research organisation. Characterised by a shift in focus to a market-orientation in support of industry.

2006-2020

Prioritising a stronger science and research capability. Transferring knowledge in ways that impact quality of life.

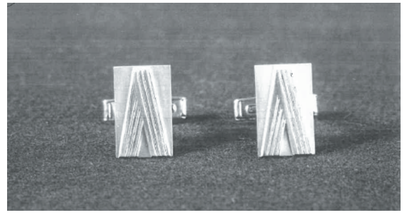
2020 ONWARDS

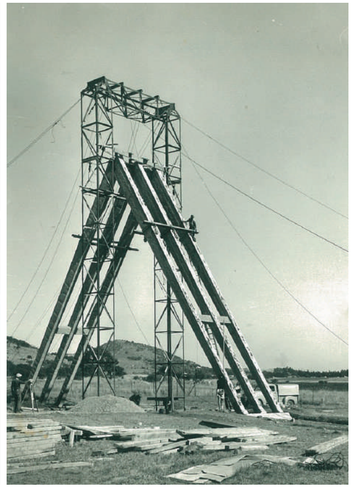
Creating a balanced impact in industry, government and society. Setting out a path for innovation-led industrial development. Aiming for growth, sustainability, impact and relevance.

1966: THE FIRST LOGO

The CSIR's first logo, a graphic rendering of its landmark A-frame entrance, was associated with the gateway to knowledge. It appeared for the first time on the covers of the organisation's annual report and a staff association brochure in 1966, the same year that the organisation celebrated its coming-of-age 21st anniversary.

The logo depicted cooperation between the three basic sciences – mathematics, physics and chemistry – in an upward and forward moving trajectory from a solid foundation to reflect the CSIR as a central scientific powerhouse established to address South Africa's technological challenges.

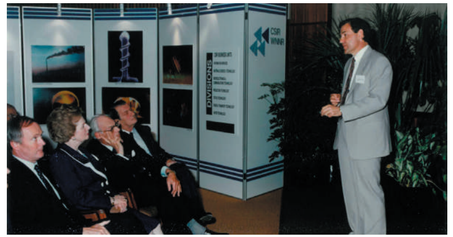




1988: THE SECOND LOGO

The second epoch, from 1988-2006, followed a major organisational restructuring during 1987-1988, when the CSIR grasped the nettle of change to position itself as a dynamic and innovative entity with an emphasis on technology transfer and commercialisation. The organisation commissioned a new logo to reflect its new reality, consisting of four equilateral triangles resembling four delta-wing aircraft flying in formation. The solid triangle symbolises the harnessing of the three basic sciences, physics, chemistry and mathematics as the foundation of the activities of the CSIR. The three repeated triangles, depicted by parallel lines, suggest the interaction of the basic sciences, their combined power forged into a multidisciplinary problem-solving force. The enclosed smaller triangles represent the public and private sectors as the focus of scientific research and the transfer of technology from the CSIR.

This logo was adapted for use by CSIR divisions in different colours and with the division's name above that of the CSIR, next to the triangles. Over the years, before the CSIR's third epoch in 2006, small adaptations to the original dark blue corporate logo were made to the size and positioning of the word "CSIR" alongside the triangles, and slight changes to the logo's shade of blue. The sign-off line, "Your Technology Partner", was added to the bottom of the logo as reflected on the cover of the 1999 annual report.



2006: THE THIRD LOGO

As the CSIR approached its 60th anniversary in 2005 at the start of its third epoch from 2006-2018, the organisation saw the need to re-communicate its *raison d'etre* – the scientific research and industrial focus of a robust research base. The resulting Beyond 60 reconfiguration process reiterated the importance of science and research in social and economic prosperity. In tandem with the CSIR's revitalisation, a new corporate identity made its debut in February 2006. The CSIR brand essence was captured in the key concepts of scientific excellence; innovation and quality; skills development; leadership in science; working through partnerships; ensuring transformation and making a real difference through science to build a better South Africa. The logotype consisted of a stylised letterform or initials and, combined with the positioning statement, *our future through science,* made up the CSIR signature. It strongly supported the renewed focus on science and research, captured in the new logo with its capital 'S' and 'R'.

2020: THE FOURTH LOGO

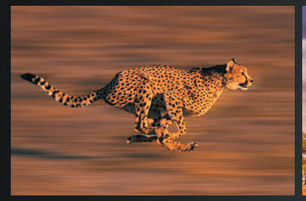
The CSIR's current epoch necessitated a relook of the CSIR brand. While the brand remained relevant in the context of the organisation's new strategic direction of making a greater impact in industry and on the economy, the organisation needed to find stronger expression of its vision of accelerating socioeconomic prosperity in South Africa through leading innovation.

A new logo was therefore adopted in 2020, that reflects equal emphasis on both the science and industrial pillars of the CSIR's mandate. The letters "CSIR" were separated, but all of equal dimension, to emphasise the balance of science and industrial development. The retention of blue as the primary colour indicates the continuity of a regal, reliable, solid and steady CSIR brand. The human figures in the icon symbolise the commitment of a people-centred organisation to improving the quality of life of all South Africans, while the tilted circle symbolises collaboration, resilience, strength and the continuity of the CSIR's research. The colours of the South African flag within the icon symbolise prosperity, diversity and unity, and show the CSIR's patriotism. The new positioning statement of *Touching lives through innovation* is aligned with the CSIR's mandate and summarises its business intent of touching lives for a better future.

Organisational values are often described as the true north of an organisation's brand compass – regardless of the direction that the organisation takes, they remain true. As part of the revision of the CSIR brand, the CSIR adopted a new set of values, depicted overleaf.

Ultimately, the CSIR brand image will always resonate with its founding purpose, made real by its people and felt in the impact of its output.

OUR VALUES



EXCELLENCE

We strive for **excellence** and quality in everything that we do. We always strive to deliver solutions that surpass the expectations of our stakeholders. We hold each other to the highest possible standard in research, development and innovation, as well as all other facets of CSIR business. We believe that excellence is a product of investing in the continuous development of our people, processes and ways of doing business.

PEOPLE-CENTRED

Our business is about **touching the lives of people**, our employees and business partners. We care about people. We respect each other's diversity and conduct ourselves in a manner that upholds the dignity of every person. We believe in continuous personal development and encourage one another to seize opportunities for personal growth. We treat our stakeholders the way we like to be treated.

INTEGRITY

We act with **integrity**. We are honest and fair when dealing with one another and our business partners. We respect the trust that our colleagues and stakeholders place in us, and commit to ethical decision-making, delivery and governance.

COLLABORATION

We are keen to learn from one another, and **collaborate** across the organisation and with external partners to ensure that our work has the best chance of innovating a better future for South Africans. We actively share our knowledge and expertise by design, formally and informally, so that we can realise large-scale impact.

OUR BRAND STORY

For Africa, the difference between today and a better tomorrow lies in finding alternative ways to progress.

At the CSIR, we passionately believe that science, technology, innovation and meaningful industrial development are the catalysts through which we can grasp the opportunities that our continent has to offer.

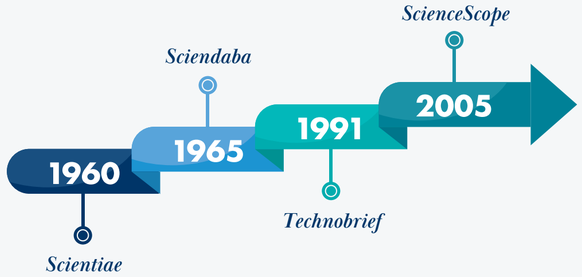
Our research is rooted in scientific leadership and innovation, as well as understanding the needs of industry and society.

Our people deliver practical and innovative technologies and solutions that contribute to a competitive South Africa and sustainable economic growth.

Our value is measured through improving the competitiveness of industry and improving the quality of life.

We use the diversity, ingenuity and energy of our people in a collaborative and agile fashion to realise tomorrow's potential.

SHARING OUR STORIES



A publication should provide the reader with photos, images and information that translate into an engaging experience. Reading such a publication should stimulate, inform and excite to the extent of creating impatience for the next edition.

Over the years, the CSIR has published information about its activities and achievements in publications targeted at its internal and external stakeholders. These have included *Sciendaba*, internally for employees, and *Scientiae*, which became *Technobrief* and later *ScienceScope*, for interested and affected parties external to the organisation. In addition, the organisation had published its annual reports without fail since the first edition in 1946, a year after the establishment of the CSIR in 1945. A closer look at the history of *Sciendaba* revealed that, from its establishment in April 1965, the internal newsletter became part of the CSIR culture and the carrier of internal news. Over time, the nature of the newsletter adapted to new technology and underwent changes in distribution, language and content policies.

"First internal newspaper launched at the CSIR" was the headline on the cover page of the very first issue and the optimism of this statement was reflected in the lead article, written by Dr Meiring Naudé, the CSIR President at the time. The need for an internal publication arose from the lack of editorial capacity in the external newsletter, called *Scientiae* (forerunner of the *TechnoBrief*, re-launched as *ScienceScope*), to publish news relating to internal matters. Dr Naudé made provision for a four-page tabloid-size newspaper to carry such information and appointed Alec Papageorge as the first editor.

The origins of the name date back to November 1964 when the CSIR held a competition for employees to come up with a name for an internal newsletter, prior to its launch in 1965. The winning entry, sent in by Jan Bosch from the Technical Services Department, won a grand total of R3 for his suggestion of '*Indaba*' for its "pleasant indigenous ring", as described by Papageorge. A decision was taken to merge *Indaba* with *Scientiae* to form the neologism '*Sciendaba*' and the name remained the same over the years. The content has covered a wide range of internal news from and about the CSIR, with a focus on what would be of interest to employees.

The story behind the CSIR's external publications started in the early 1980s, when the CSIR Council members who represented the business world observed that there was no formal mechanism in place for measuring the organisation's value to industry or the community. Other than scientific papers, the only publications communicating the CSIR's progress and value to the country at the time, were the annual report to Parliament and a quarterly journal, *Scientiae*, aimed at the public but with a limited circulation.

The CSIR's Executive decided to launch a monthly news bulletin, *Technobrief*, in April 1991, following the final issue of *Scientiae* earlier that year. It took the form of a tabloid with short punchy items on the latest developments at the CSIR, replacing *Scientiae*, which concentrated on long, informative articles. *Technobrief* became a source of numerous enquiries, often leading to the conclusion of new contracts. Items reproduced from *Technobrief* in other publications, such as the *SA Product Digest* and many other publications, elicited enquiries from all over the world.

In 2005, at the time of the CSIR's 60th anniversary, *Technobrief* changed shape to become *ScienceScope*, the current version of the CSIR's external newsletter.

2018

The CSIR's annual report and *ScienceScope* are named second runners-up at the SA Publication Forum Awards.

2017

The CSIR website is the second runner-up at the SA Publication Forum Awards in the category for best corporate website, while *ScienceScope* receives certificates of excellence in design and communication as a finalist in the categories for best design and best external magazine.

2015

ScienceScope - Ideas that work is named South Africa's third-best magazine by the SA Publication Forum.

2014

The careers edition of *ScienceScope* is named South Africa's second-best corporate publication by the SA Publication Forum. The publication beats an array of consumer publications.

2013

Sciendaba online Volume 62, which features the 2012 CSIR Excellence Awards winners, wins the award for the best digital publication at the South African Publication Forum 2013 Awards; it was judged on writing, layout and user-friendliness.

2012

The *ScienceScope* editions focusing on climate change and advanced manufacturing are finalists in the category for South Africa's top corporate publications of 2012. The climate change edition is named second runner-up in the category for best external publication (category B for low-budget publications), while the advanced manufacturing edition is the runner-up. The two editions of *ScienceScope* are tied in second place in the best achievement in design category, while both editions receive certificates for excellence in communication, writing and design.

2002

The CSIR receives a silver award for best sustainability disclosure in an annual report in the public entities category of KPMG's Fourth Annual Sustainability Reporting Survey.

Communication tools have changed radically in the CSIR's 75-year history. Today, in addition to the publications outlined (and the use of traditional promotional tools), the CSIR also markets its expertise and competences digitally – producing videos and vodcasts, maintaining a presence on social media and hosting webinars.

CSIR archives technician Itumeleng Nthite with the CSIR's first annual report (1945/46), and its 75th annual report (2019/20).

The CSIR's *Sciendaba* collection, dating back to the first edition in 1965.

The CSIR's full annual report collection, 1945 to 2020.

The new democracy annual report collection, 1994/95 to 2019/20.

OUR IMPACT

For 75 years, the CSIR has harnessed the collective expertise of its scientists, engineers, technologists, technicians and support staff to create innovative technological solutions that meet the needs of the country and its people. Its impact on economic development and societal well-being remains irrefutable.

Throughout history, humans have looked for better ways to meet their daily needs. Over time, technological developments – innovative, new thinking and action – became the mainstay of inventions that improved individual livelihoods and societal well-being. The CSIR's mandate commits us to conduct research and foster technological innovation and industrial and scientific development to improve the quality of life of South Africa's people. Over the years, our efforts have resulted – and continue to result – in many successful innovations and interventions. These efforts are a response to national priorities and are based on innovative ideas that can be practically applied to better the lives of citizens.

"From the outset it was the philosophy of the CSIR that research undertaken in a state-supported research organisation could not be regarded as an end in itself and that procedures should be developed to ensure that the results of research would be put to practical use." – Denys Kingwill, *The CSIR – The first 40 years, 1990:102*

The use of technology has permeated almost every aspect of our existence as we know it today. For many, life has become easier, faster and more comfortable. Rapid technological change has revolutionised human communication and impacted the business world. Entrepreneurs can more easily expand their businesses globally and consumers are empowered to buy products and make payments online or from a mobile device. And the use of the Internet has created a modern society with access to telecommuting at any time, with anyone and from anywhere across the globe.

The dynamic evolution of scientific disciplines and associated technologies has contributed to a diverse range of applications. Internally we have seen our infrastructure built from modest beginnings, rebuilt and our administrative structures designed and re-designed. And at the core of this organisation, our people have joined, grown and contributed. Those who left invariably applied their experience in the organisations they joined or to the companies they formed. We are valued partners to clients and stakeholders nationally and our ties with international research counterparts provide access to complementary expertise and infrastructure that enable us to address key national issues. As a leader in science and technology, the CSIR will continue to play a vital role with meaningful and sustainable impact in the development and use of scientific research and technological solutions and innovations to serve society and stimulate economic growth for the country.

A small selection of stories about the CSIR's impact over the years is depicted on the following pages.

AN EYE FOR DISTANCE – A WORLD STANDARD IN SURVEYING FOR OVER 25 YEARS

DISTANCE MEASURING INVENTION USED BY SURVEYORS THROUGHOUT THE WORLD

A vintage South African invention with a long and glorious international history that earned the CSIR and its inventor global recognition

Although ground-breaking technology at the time, twentieth century radar used to measure distance and direction was not sufficiently accurate for normal land surveying.

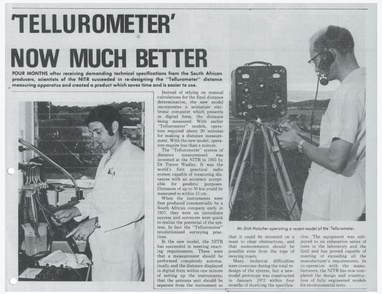
In the early 1950s, when South Africa's Department of Trigonometrical Survey needed a portable, line-of-sight system with accuracy greater than 1 in 100 000 at a distance of up to 30 miles and a resolution of a few inches, the responsibility fell on Dr Trevor Wadley, an electrical engineer in the CSIR's Telecommunications Research Laboratory in Johannesburg.

In a remarkably short time, he invented the tellurometer – the first microwave electronic distance measurement equipment that revolutionised land surveying throughout the world. The company set up to manufacture the device – Tellurometer Pty Ltd, later Tellumat – maintained the market lead for this equipment for over 25 years.

Designed to yield geodetic accuracy over geodetic distances, the tellurometer was also useful for second-order work, especially in areas where the terrain was rough and temperatures extreme. With a normal range of 30-50 km, the tellurometer could penetrate haze and mist in daylight or darkness.

Reports from over 48 countries, as far afield as Alaska, Australia and Malaysia, confirmed that Wadley's distance measurement system could survey more accurately and cost-effectively than other systems.

The tellurometer was unveiled in Constantia, South Africa, in January 1957 and patented in at least 11 countries. By 1962, the tellurometer was acknowledged widely as having transformed land surveying and increased work output in ways that would have been almost impossible in the days before the invention.



'TELLUROMETER' NOW MUCH BETTER

FOUR MONTHS after receiving demanding technical specifications from the South African producers, scientists of the NITR succeeded in re-designing the "Tellurometer" distance measuring apparatus and created a product which saves time and is easier to use.

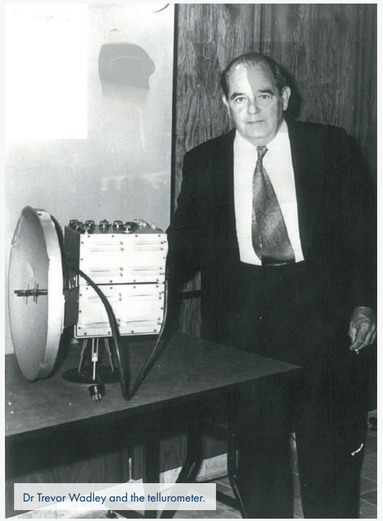
Mr Dirk Fletcher operating a scaled model of the Tellurometer.

The *Sciendaba* of 27 April 1973 reported that the tellurometer had been improved.

IMPACT OF THE TELLUROMETER

- High-accuracy distance measurements over geodetic distances.
- Could penetrate haze and mist in daylight or darkness.
- Useful for second-order survey work over rough terrain and at extreme temperatures.

The tellurometer was replaced by the use of satellite receivers and later by laser rangefinders, commonly using time-of-flight.



Dr Trevor Wadley and the tellurometer.

THE BOLLARD – 30 YEARS OF PROSTHETIC EXCELLENCE

A CSIR INVESTMENT THAT STOOD THE TEST OF TIME

Medical implants can be life-saving. They can restore mobility, improve quality of life, cut the costs of ill-health and enable people to return to work. A key challenge is to invest in innovations that meet patient needs and expectations and are safe and effective.

In the early 1980s, the CSIR invested in biomaterials research, specifically composite materials, for high-duty applications. This opened up a new field of research into the use of carbon-fibre reinforced composites for surgical implants and resulted in the bollard, which formed part of a ligament repair kit that was marketed worldwide.

Invented by researchers Peter Mundell, Dr Michael Hunt and Dr Angus Strover in 1982, the bollard is an implantable expanding rivet used to attach artificial ligaments to bone in ligament repair operations. The trio's research focused on using composite materials – carbon-fibre reinforced polysulfone (a family of thermoplastics) – with a similar strength but biomedically more compatible than the metals used for surgical implants at the time.

Sales of the device started in 1984 through the CSIR's technology commercialisation company, Technifin. In the same year, the bollard received the Chairman's Award for Excellence (at that time the Shell Design Awards) from the SABS Design Institute. It was also the first carbon-fibre reinforced composite implant approved by the US Food and Drug Administration for human surgery.

Co-inventor Peter Mundell left the CSIR in 1989 to set up Fibretek Developments CC (later Fibretek Developments (Pty) Ltd) as one of the first South African medical device manufacturing companies to develop export markets for its products. The company employed five staff members at the height of product development and sales. The product was marketed from the United Kingdom.

"Very few companies, if any, can sustain themselves on income from a single product, but Fibretek had sufficient sales in the early years to invest in the development and commercialisation of other products, such as the Optoscan Visual Field Scanner and the Cape Town Stereotactic Pointer." – *Peter Mundell (CSIR Licensing and Ventures fact sheet, February 2014).*

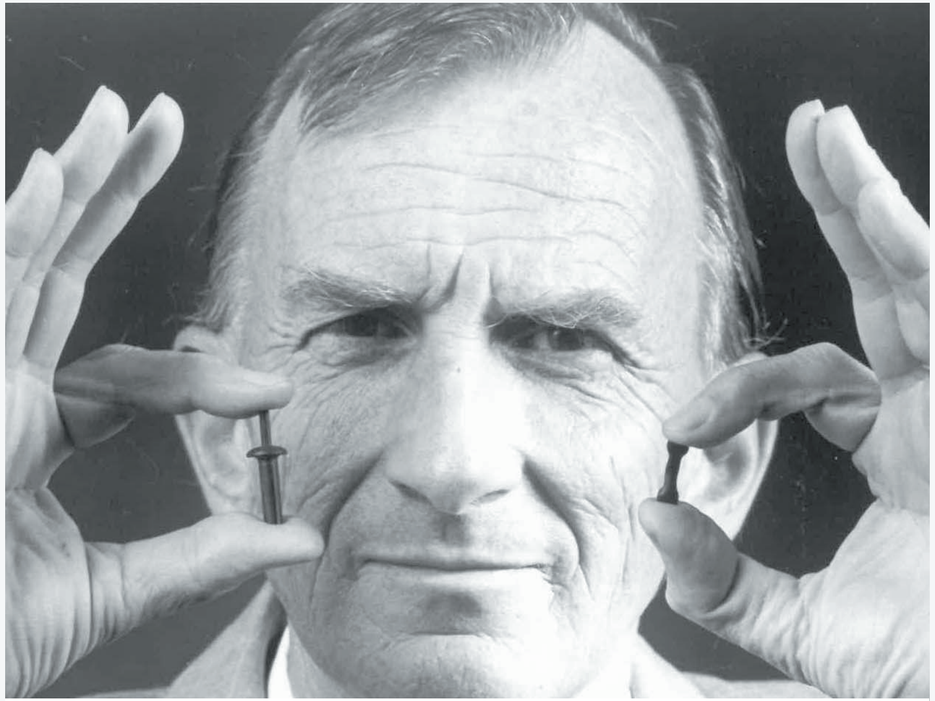
Since 1984, Fibretek Developments manufactured and sold over 60 000 bollards, with a final sale of 250 units in 2013. The company also developed and sold the Optoscan Visual Field Scanner and the Cape Town Stereotactic Pointer, but the bollard was its mainstay over an almost 30-year lifespan.

"It is very unusual for a medical device to be on the market and remain in demand for such a long period, but the bollard succeeded in doing just that. The success of the product and the long-term sustainability of the manufacturing company are truly a testimony to the innovative design by its inventors at the CSIR in the early 1980s." – *Sean Moolman, CSIR Group Manager Licensing and Ventures (CSIR Licensing and Ventures fact sheet, February 2014).*

IMPACT OF INVESTMENT

- Over 60 000 bollards sold globally.
- A 30-year lifespan.
- Locally manufactured, marketed from the United Kingdom.
- Final sale of 250 units in 2013.

The carbon-fibre bollard was used as an attachment device for prosthetic ligaments in the knee.



Dr Michael Hunt, leader of the team behind the development of two internationally accepted surgical implant devices, known as the bollard and toggle.

75 YEARS AND COUNTING – THE CSIR AT THE FOREFRONT OF RADAR TECHNOLOGY IN SOUTH AFRICA

LEADING THE IMPACT OF A STRATEGIC CAPABILITY

Radar technology is undeniably critical in today's world. In a military context, it is used for applications such as intelligence collection, wide-area surveillance, early warning, real-time situation awareness, weapon guidance, self-protection, navigation and military air traffic control. Civilian applications include air traffic control, maritime navigation, weather observation, traffic management, Earth observation (from aircraft and spacecraft) and even space exploration (planets and asteroids). In addition, radar-based innovations are recognised globally for stimulating industrial development, competitiveness and job creation.

The CSIR's founding President, Sir Basil Schonland, led the team that received the first radar echo in South Africa in 1939. After the war, in 1946, he established the Telecommunications Research Laboratory at the CSIR. It became one of the foundations of the electronics industry in South Africa, including the radar and electronic warfare industries. Schonland also motivated for the establishment of a defence research and development capability at the CSIR to support the South African National Defence Force (SANDF) in its force acquisition, preparation and employment.

In 1951, the CSIR started to develop the JB51, a long-range surveillance radar that met the requirements of the South African Air Force (SAAF). By 1957, the technology had been developed, transferred to Marconi South Africa and a pre-production model produced. Deployed at Pienaars River, north of Pretoria, the SAAF used the JB51 to train pilots and ground-controlled intercept fighters.

Over more than seven decades, the CSIR continued to support the SANDF and made a critical contribution to the National System of Innovation in radar and electronic warfare. Local and international clients make use of the CSIR's cutting-edge technologies and its ability to establish capabilities of similar calibre in other organisations and countries.

The wide spectrum of CSIR radar research and technological innovations included innovations in surveillance radar systems (situation awareness), tracking radars (ground- and ship-based air defence gun direction and missile guidance), synthetic aperture radar (intelligence collection and Earth observation), platform protection radar (missile and bullet detection), radar signature measurement and modelling, passive coherent location technology development (air traffic control), radar warning and interception, radar countermeasures, electronic warfare solutions and adaptive jammer/electronic attack technology (advanced signal processing, machine learning and multi-threat engagement capabilities) and radar electronic counter-countermeasures (low sidelobe antennas, wideband transmitters and receivers, sidelobe blankers and cancellers, high-range resolution processors with robust tracking filters, wideband frequency agility, and constant false alarm rate detectors).

Some of the radar developments with significant impact over the years, are outlined below.

- Millimetre wave monopulse tracking radar technology, developed under Project Fynkyk, was transferred to Reutech Radar Systems in Stellenbosch in the late 1980s. This formed the basis of the tracking radar division at a newly established radar company in South Africa, nowadays known as Reutech Radar Systems (RRS), which saw the first RSS industrialised tracking radar, the ETS 2400.

- Wideband monopulse Doppler tracking radar technology, developed under Project Meccano, was transferred to RRS during the 1990s. Designed to satisfy South African Navy (SAN) requirements for the main fire control radar of its Valour class frigates, RRS used the Meccano technology and concept design to design and develop the Optronic Radar Trackers (ORTs), the RTS 2400. ORT became operational in 2006 as part of the proudly South African air defence fire control system of the SAN frigates. During the early 2000s, the CSIR and RRS continued to support the SAN with performance improvements to the ORTs electronic counter-countermeasures and its low-level tracking accuracy.

- Missile approach-warning radar technology for the self-protection of helicopters was developed at the request of the SAAF. The technology is being adapted for use as a hostile fire detection sensor for helicopters in collaboration with Saab Grintek Defence.

Demonstration of a complex radar system at the test range at Paardefontein, north of Pretoria, Gauteng, in 2013.

- Wide-area persistent surveillance technologies were developed as part of the CSIR's Awarenet programme. It included research into the detection, tracking and radar-based classification of small boats, people, vehicles and aircraft involved in smuggling, poaching, illegal fishing, drug trafficking and border crossings. This helped South Africa to protect its territory and people against illegal activities. One of the applications of the technology was the development of an integrated wide-area surveillance system to detect, track and classify rhino poachers in the Kruger National Park. The resulting technology demonstrator was dubbed *Meerkat* by SANParks and applied with great success in counter-poaching operations. Meerkat is based on an RRS surveillance radar for detection, geo-location and tracking and a CSIR-developed long-range, day-and-night camera system for target classification. The CSIR radar team received an innovation award from SANParks for this development. Based on insights from the Meerkat programme, the CSIR, in 2021, developed a new version surveillance radar to safeguard our borders, parks, key points, mines and farms. It makes use of CSIR-developed, low-cost phased array antenna modules and adds radar-based target classification to the standard radar detection and tracking functions for a solution with increased performance and lower costs.
- The CSIR phased array antenna modules are also being used to develop and commercialise a new-generation tactical 3D surveillance radar for naval and land-air defence systems in collaboration with Hensoldt South Africa. This project will modernise one of Hensoldt's key radar product lines and further enhance its extensive radar portfolio at a very competitive price.
- The CSIR used its up-to-date radar expertise, developed on numerous radar technology projects, to provide impartial technical advice to the Department of Defence for more than seven decades. This included acquisition support to the SAN on tracking radar for its frigates; the SA Army on new-generation ground-based air defence radar systems; the SAAF on electronic countermeasures against ground-based air defence systems, airborne multifunction radars for Cheetah C and Gripen fighters and new air defence surveillance radars, as well as military air traffic control, precision approach, missile approach warning and maritime patrol helicopter surveillance radars.

PRINCIPLES AND ADVANTAGES OF RADAR

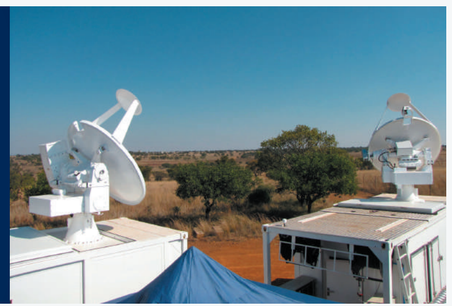
- Radar is a remote-sensing technology that makes use of the reflections of electromagnetic waves off objects of interest to determine their presence, 3D location, speed and type.
- Radar can sense objects at long ranges (hundreds of kilometres) and in most weather conditions, through smoke, dust, clouds and rain, during day and night.

Radar technology became a competitive force globally after WWII. At the time, a small group of brilliant minds was already working in this field in South Africa. Their work formed the basis of a defence R&D capability that, to this day, gives the country a competitive industrial and security edge, while providing the Department of Defence with up-to-date, impartial advice and technology solutions.

"Looking back over the long history of radar at the CSIR, what stands out is the passion, dedication and teamwork of successive generations of electronic engineers, scientists and technicians who continued to grow the radar R&D capability in South Africa, despite changing political decisions and economic fortunes. They made it their business to master radar and its multitude of sub-disciplines with the aim of serving South Africa and its needs for defence, peace, safety and security on one hand, and industrial growth on the other.

Combining the exponential growth in radar knowledge in the world with the explosion in new materials, components and tools available to implement new radar innovations, they continue to achieve new heights of functions, performance and impact, while guiding new generations of talented young people into exciting and fulfilling careers."

– Francois Anderson, CSIR chief radar and electronic warfare systems engineer (retired, personal contribution, August 2021).



AERODYNAMIC PERFECTION – WIND TUNNEL RESEARCH FOR DESIGN EXCELLENCE

AERONAUTICS CAPABILITIES THAT BENEFIT CIVIL AEROSPACE

Testing within a wind tunnel simulates the flow environment encountered by an aircraft during flight. The wind tunnel generates wind or air flow over a static airframe supported in a controlled test environment.

Aerodynamic design in South Africa's aeronautical industry has, for many years, benefitted from the scientific research and experimental foundation of the CSIR's suite of wind tunnels. Installed at the Scientia campus in Pretoria over a period of more than three decades, since the late 1960s, the suite's flagship, the transonic medium-speed wind tunnel, was completed in 1989.

The CSIR currently operates six aerodynamic wind tunnels, a water tunnel and three specialised gas turbine test facilities. The four main commercial tunnels cover a speed range from very low subsonic speed, up to 4.3 times the speed of sound in the supersonic facility. The tunnels are used commercially to characterise airframes for clients.

Generally, wind tunnel facilities are classified according to the speed of sound (sonic), as subsonic (flow speeds lower than the speed of sound), supersonic (higher than the speed of sound) or transonic (both higher and lower than the speed of sound).

In the subsonic tunnels, the test section sizes range from 7.5 m x 6.5 m in the 7 m wind tunnel, with a maximum speed of 32 m/s, to 2.1 m x 1.5 m in the closed-circuit low speed wind tunnel with a maximum speed of 120 m/s. On the high speed end, the transonic wind tunnel has a square cross-section test section of 1.5 m x 1.5 m and reaches speeds of Mach 1.4, while the high speed (supersonic) wind tunnel has a test section of 0.45 m x 0.45 m and can reach Mach 4.3.

The design of flight vehicles requires significant industrial investments and poses a huge burden on the developer to 'get things right' the first time. While sufficient accuracy in airframe performance prediction is important for the economic viability of the product, this has to be balanced by other equally important aspects, such as safe operation and purposeful performance to specification, to ensure its ultimate success. Relying only on a flight test of a prototype and discovering inefficiencies against specifications can lead to the failure of a development programme. A wind tunnel provides an optimal tool to study and determine performance predictions early in the design phase.

A wide range of airframes has been tested in the CSIR wind tunnel facilities. These range from subsonic types, such as gyrocopters, helicopters, unmanned aerial systems and military trainers, to transonic-type airframes, such as bombs and combat aircraft, to supersonic airframes of high-speed missiles and projectiles flying at more than four times the speed of sound. Data collected at the facilities are used for airframe

The first image-plane tests carried out in the CSIR medium-speed wind tunnel, using the half model of the airframe used in a project that investigated the use of joined-wing configurations and morphing-wing solutions.

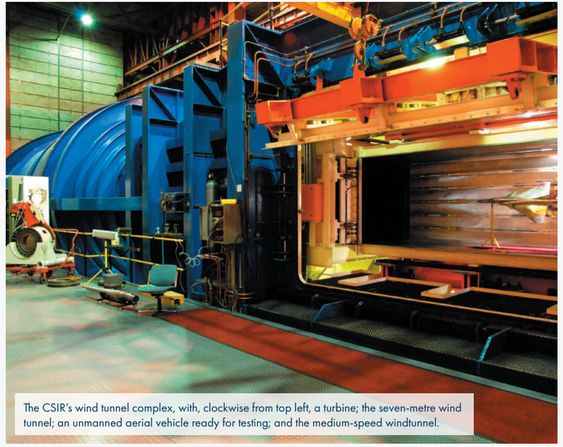
characterisation and to populate complex modelling and simulation environments for broader mission simulation predictions, doctrine development and training.

The CSIR used its seven-metre wind tunnel to test the BRAYFOIL, a patented South African invention of an auto-setting morphing wing named after its inventor, South African architect, Robert Bray. The wing can, instantaneously, reverse lift from one surface to another and sets an appropriate angle of attack with the shape change automatically relying on a reflex section form in the morphing transition. The first full-size wing was tested at the CSIR in Pretoria in February 2018. The tests provided valuable information about the profile shape best-suited for this embedded power-wind application. The wing also has application in hydro power, aircraft, wing sails and active automotive force wings.

"Ultimately, we are empowering a world-class, competitive aerospace industry through the advancement of aerodynamics research, design, development, test and evaluation through our facilities and our people."
– Dr Kavendra Naidoo, Manager of the CSIR Aeronautic Systems Research Group (ScienceScope 2018, 13:1, 31).

IMPACT OF WIND TUNNEL TESTING

- The CSIR's suite of wind tunnels supports industry growth.
- Wind tunnel testing is used to predict the aerodynamic behaviour of externally mounted stores and fuel tanks on aircraft.
- Wind tunnel facilities provide a large pool of research test cases and resources that support the training of young aeronautical engineers at universities.



The CSIR's wind tunnel complex, with, clockwise from top left, a turbine; the seven-metre wind tunnel; an unmanned aerial vehicle ready for testing; and the medium-speed windtunnel.

SPACE, THE FINAL FRONTIER – IN PURSUIT OF A GREATER GOAL

THE PEACEFUL EXPLORATION OF OUTER SPACE FOR THE BENEFIT OF HUMANKIND

In 1957, a group of talented CSIR engineers in Johannesburg were preparing to operate a satellite tracking station to support America's planned launch of the world's first artificial satellite. But it was the Russians who pipped them to the post and laid claim to that coveted achievement – one that initiated the space age and brought about astonishing scientific and technological achievements.

Within days after the launch of Sputnik-1, the CSIR engineers had devised a tracking system, solved the orbital mechanics to track the satellite and calculated when it would be visible over southern Africa and re-enter the Earth's atmosphere. Their predictions were acknowledged globally as being the most accurate.

The unique characteristics of that unprecedented response in 1957, and the investment by America's National Aeronautics and Space Administration (NASA) in the installation of Africa's first hydraulically driven 12 m X/Y parabolic antenna at Hartebeesthoek[1] in 1963 to receive data from interplanetary monitoring platforms on behalf of its Goddard Space Flight Centre (GSFC), augured well for the CSIR's 50-year-long active participation in the world's space operations.

During the first 15 years at Hartebeesthoek, from 1960 to 1975 (often referred to as the NASA years), the CSIR operated the NASA-equipped Minitrack (renamed the Satellite Tracking and Data Acquisition Network or Joburg STADAN in 1961) and Deep Space ground stations on behalf of NASA. The stations respectively provided the GSFC in Maryland with telemetry, tracking and control (TT&C) services for its Earth-orbiting satellites and the Jet Propulsion Laboratory in Pasadena, California, with mission support for the US deep space research programme.

In 1976, following NASA's departure from the country in 1975, the CSIR re-established the Deep Space Station as a radio astronomy observatory and the Joburg STADAN as the Satellite Remote Sensing Centre, the latter to acquire and process data from meteorological and geostationary Earth-observation satellites, initially the Meoteosat-1 satellite and later the Landsat Earth resources satellites, following an agreement with NASA in 1982.

The South African Weather Bureau was the first recipient of Meteosat data. All the satellite data received at the time were made available for research projects in geology, oceanology, agriculture, forestry, land-use and developmental studies in Africa. The CSIR at Hartebeesthoek was the first ground station globally to receive and combine Meteosat and Landsat data and, as a result, became the first regional centre for

1 *The CSIR's remarkable 50-year involvement in space operations at Hartebeesthoek, an often untold story, is relayed in the coffee table book, The SAC Story – Commemorating 50 years of the CSIR Satellite Applications Centre 1960 – 2010. Electronically available at https://www.sansa.org.za/2015/12/15/new-sac-book/*

The 5.4 m X-band antenna at Hartebeesthoek is used to download Earth observation data.

receiving and distributing imagery that covered most of Africa south of the equator. The activities quickly developed into a significant knowledge base in satellite data acquisition, image processing and distribution, and advanced remote sensing application development.

By then CNES, the French space agency, had contracted the CSIR for TT&C support for its Ariane satellites and the CSIR became a key participant in many CNES launch missions. Following the successful fulfilment of a number of TT&C contracts for the French, European and Canadian space agencies (CNES, ESA and MDA) in the late 1980s and 1990s, the CSIR installed a 13.2 m Ku/DBS-band antenna at Hartebeesthoek in 1998. The installation included on-the-job training in civil, mechanical, electrical and electronic systems and was completed in an unprecedented, world-record time of nine months, to international acclaim.

In 1994, NASA contracted the CSIR (for the first time in 25 years) to provide TT&C support for its Clementine moon mission and the 10-minute lunar transfer orbit burn, which boosted the satellite out of its Earth orbit on a trajectory to the moon. A contract with Hughes Space and Communications (shortly before its incorporation into the Boeing aerospace company in 2000) saw an investment by Boeing for the installation of a 13.2 m Ka-band antenna (complementary to the Ku/DBS-band antenna) in 2002 to support the launch of its Delta-IV satellites. The investment confirmed Boeing's confidence in the accuracy and reliability of the CSIR mission support team – critical in an industry where there is little margin for error.

Over time, the CSIR expanded its antenna capacity at Hartebeesthoek from three antennas with minimum capabilities, to 22 antennas with a full frequency spectrum. From tracking Early Bird, the world's first commercial communications satellite in 1964, to providing TT&C services to a range of international clients, the CSIR created a robust reputation that supported its commercialisation drive in the early 2000s. Clients at the time included Boeing, CNES, ESA, Hughes Space and Communications, Intelsat, Lockheed Martin, MDA and NASA.

The additional satellite data received at Hartebeesthoek supported the compilation in 2007 of a 2.5 m natural colour seamless mosaic of South Africa, a first-of-its-kind on the continent. Using data from the SPOT-5 satellite, the Earth observation team at Hartebeesthoek achieved significant milestones in the creation and delivery of the mosaic. A multi-government agreement with SPOT Image, a CNES subsidiary at the time, enabled the CSIR to distribute the data free of charge to users in government entities, universities and research institutions for developmental, academic and research purposes.

The mosaic data applications included spatial planning of informal settlements, as well as planning and informed decision-making for the electricity grid, land-usage, agricultural boundaries, and water and disaster risk management. Access to the data also informed decision-making about food security, housing, mine rehabilitation, and national safety and security.

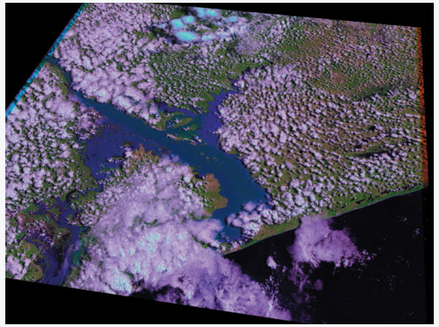
In 2009, the construction of a second 7.3 m full-motion X-band antenna at Hartebeesthoek extended the CSIR Satellite Applications Centre's sensor portfolio and antenna capacity to track new-generation satellites, as well as the priceless archive of Earth observation data – at the time 150 terabytes that dated back to 1972. In 2010, the centre took over mission control for South Africa's SumbandilaSat Earth observation pathfinder micro-satellite through the use of its large dish antenna. The event at Hartebeesthoek was attended by then Minister and Deputy Minister of Science and Technology, respectively Dr Naledi Pandor and Derek Hanekom.

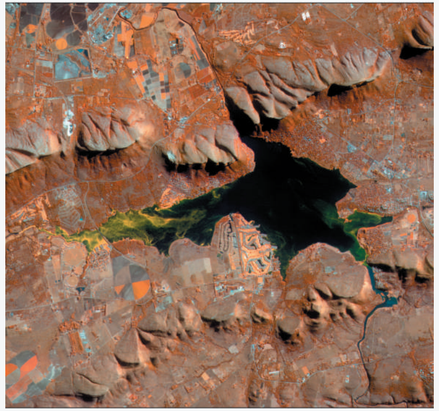
The CSIR closed the door on the Satellite Applications Centre era in 2010, when the activities at Hartebeesthoek were incorporated into the then newly established South African National Space Agency. The 50-year track record of exceptional performance in space operations and remote sensing has left the country with a unique space infrastructure and an invaluable database of satellite image data products shared throughout Africa.

"There are many agendas for space exploration but none more important to South Africa than looking after our own country and monitoring its progress. The CSIR's highly successful Satellite Applications Centre is at the forefront of this critical endeavour." – *Dr Mosibudi Mangena, former Minister of Science and Technology at the inauguration of the 7.3 m X-band antenna at Hartebeesthoek on 25 March 2009.*

IMPACT OF THE CSIR IN SPACE OPERATIONS

- Global reputation for accuracy and reliability in space mission support.
- Societal, academic and research benefits from the application of space technologies and satellite remote-sensing data.
- Legacy of a world-class space infrastructure.





The 12 m antenna at Hartebeesthoek (right), installed in 1963, was one of only three installed by NASA around the globe, with the other two in Chile and Australia. Landsat TM images captured the cloud cover over flood-ravaged Mozambique in March 2000 (far right top) and a satellite image captured over the Hartebeestpoortdam in North West (far right bottom) for water quality studies.

HOME-GROWN – THE HEAVY VEHICLE SIMULATOR

A CSIR SUCCESS STORY WITH A GLOBAL FOOTPRINT

Roads create the arterial networks that give life to economic activity and individual mobility. But roads are expensive. At a cost of between R8 million and R15 million for a 1 km single lane stretch, extending the 30-year lifespan of a road matters. High traffic volumes, heavy vehicles, overloading and poor construction can damage roads prematurely.

A road is designed to last between 20 and 30 years if constructed and maintained correctly. New road designs and materials must be tested over a long period of time to assess its traffic response – a costly and time-consuming approach. The CSIR's heavy vehicle simulator (HVS) is a mobile laboratory that simulates 20 years of heavy traffic in just three months. With its surface instruments and embedded sensors, the system rapidly tests new road building materials and design methods.

The HVS has won international acclaim for its success in enhancing road engineering in South Africa and abroad. The technological and economic impact of the HVS programme on designing, constructing and maintaining road networks locally and abroad is irrefutable. Decision-makers and road builders continue to depend on its research results to improve road designs and select the best construction materials.

Direct cost-saving benefits are significant and estimated at a 10:1 benefit/cost ratio. This does not include downstream- and indirect benefits, such as human capital development, advances in instrumentation and international exposure.

Since its development in the 1960s, the HVS has been modernised by the CSIR development team – Dr Chris Rust, Dr Morris de Beer, Dr Louw du Plessis and Benoit Verhaeghe – and a commercialisation partner in the United States of America (USA), Dynatest. The HVS technology platform was licensed to Dynatest in 1994.

"The development of the HVS started before we even had computers. By the early 1990s, after having operated a fleet of HVS machines successfully in South Africa, we wanted to share the success internationally to create a market need for the technology." – *Dr Louw du Plessis, expert in accelerated pavement (road) testing and co-chair of the Accelerated Pavement Testing International Alliance Committee of the International Transportation Research Board (ScienceScope 2013, 6:3, 36).*

The company markets, sells and manufactures the machines and maintains those in active use in countries such as Argentina, China, Costa Rica, India, Indonesia, Mexico, Saudi Arabia, South Korea, Sweden and the USA. The US Federal Aviation Administration owns a double-sized machine that can load airfield pavements to 400 kN. The CSIR receives royalties for HVS sales.

The CSIR also developed and patented a new conceptual design, the traffic stream simulator, for an advanced HVS that can test at much higher speeds and simulate a stream of mixed traffic.

HVS operator Joseph Marima demonstrating a heavy vehicle simulator at the CSIR in Pretoria.

Heavy vehicle simulators such as those used by the Gauteng Provincial Department of Roads and Transport, simulate the dynamic loading effects of trucks on a road and evaluate the structural response.

GLOBAL IMPACT

- Eighteen active units exported worldwide.
- R250 million in foreign revenue since 1994.
- Impressive global impact in improved road design and construction practices.

"I remember a warm summer's day at the OR Tambo International Airport when an early HVS was loaded into an aircraft for export to the United States Army Cold Regions Research Engineering Laboratory. With the 55 ton load on board, the aeroplane struggled to lift off. It was the largest single piece load ever flown out of this airport at the time. I felt a sense of pride and achievement."

– Dr Chris Rust, former CSIR researcher and traffic stream simulator inventor (CSIR Sciendaba@70, 2015 and personal contribution, June 2021).

The CSIR's research continues to support the cost-effective and efficient rehabilitation of road networks nationwide, such as in Gauteng, where the majority of roads have reached the end of their design lifespan. Recent work with the HVS validated the use of nano-modified emulsion to upgrade substandard road building materials. This effected a 40% saving in material cost and a 50% saving in construction time.

International collaboration and sales led to the formation of the HVS International Alliance. Members are owners, funders and operators of accelerated pavement testing facilities worldwide who meet annually to share knowledge and resources and coordinate HVS-related research.

Stakeholders and research partners include the South African National Roads Agency Limited, Gauteng Department of Roads and Transport, California Department of Transportation, Cement and Concrete Institute and Southern African Bitumen Association.

HEAVY VEHICLE SIMULATORS AROUND THE WORLD

TECHNOLOGY THAT SEES THE INVISIBLE – A FIRST-OF-ITS-KIND, GLOBALLY

VISUAL DISPLAY OF DEFECTS IN HIGH-VOLTAGE ELECTRICAL INSTALLATIONS

Power utilities worldwide must manage power networks efficiently to meet increasing demands for electricity. That means identifying faults in time to prevent the loss of power and blackouts.

Defects in high-voltage electrical installations cause a corona discharge (ionised air) that is invisible to the naked eye as it falls outside the range of light that humans can see. This made preventative maintenance of these installations challenging and created the need for dedicated inspection systems.

In 1992, researchers at the CSIR collaborated with Eskom to develop the world's first corona camera, the CoroCAM, to overcome this challenge. The single compact device detected, captured and visualised the invisible ultraviolet discharges on camera, enabling Eskom to repair electricity faults along power lines before blackouts occur.

Licensed to a CSIR spin-off, UViRCO Technologies, in 2008, CoroCAM became a significant commercial success. The technology has been a market leader in ultraviolet detection and imaging cameras for over 23 years.

Nine models are currently being manufactured, each having pushed the boundaries of existing technology. The first corona detection

The CoroCAM 7 is typically used to inspect high-voltage infrastructure for corona discharges and arcing.

camera could record at night only, while the latest and most popular models, such as the CoroCAM 504 and CoroCAM 6D/6N, can record faults during daylight and at night.

The CSIR's continued development work in this field resulted in a new development in 2020, when the powerline inspection systems became the first ever to radiometrically quantify the ultraviolet light emitted from pylons, a feature for which the CSIR has registered international patents.

"The CoroCAM range of products has seen South Africa develop and export home-grown technology and capture a sizeable portion of the world market in a highly specialised field." – *Jeremy Wallis, Impact Area Manager, CSIR industrial sensors (ScienceScope 2015, 8:2, 80-81 and personal contribution, 12 August 2021).*

IMPACT OF THE COROCAM

- Achieved global impact.
- Generates foreign revenue.
- Creates employment.
- Makes invisible corona discharge, visible.

Corona discharge is an unwanted side effect of high-voltage electrical installations. The phenomenon results from ionised air in a high-electric field around loose cables, cracks or badly designed equipment.

The CoroCAM® 8 UAV is a combined thermal infrared, solar blind corona and video camera, sized and balanced to fit into a standard commercial gimbal and to be lifted by an enterprise-grade unmanned aerial vehicle.

TECHNOLOGY THAT SAVES LIVES – REDUCING THE STILLBIRTH RATE BY UP TO 50%

A SUCCESS STORY WITH A LOCAL AND GLOBAL IMPACT

Preserving life is sacrosanct. Yet, almost two million babies are stillborn every year, the majority in African and south Asian countries, where cause of death is often not investigated.

Unexplained stillbirth is the largest category of perinatal death in South Africa. Eighty per cent of mothers who experience stillbirths are considered low-risk and clinically normal. When a stillbirth occurs, the psychological effect on the mother and her immediate and extended family is immeasurable.

Currently, the adopted approach to determine the fetal growth rate at the primary care level in South Africa involves using a measuring tape to take a symphysis-fundal measurement. Due to the differences in fetal development rates, the accuracy of this approach varies. Fetuses identified as being at risk by this approach are referred to a higher level of care for a more expensive imaging Doppler ultrasound. The Doppler ultrasound technology requires a specialist sonographer to perform the ultrasound and interpret the results. The combined cost of the equipment and specialist healthcare workers makes the technology unaffordable for smaller centres, such as antenatal and primary healthcare clinics in developing countries.

A CSIR/South African Medical Research Council development of a low-cost continuous-wave Doppler analyser, the Umbiflow, has reduced the excessive costs. The Umbiflow ultrasound probe is plugged into a standard, commonly available personal computer, where the Umbiflow software captures the Doppler ultrasound information, applies advanced processing techniques and presents the results in an easy to interpret 'traffic light' (green, amber and red) output. With this approach, green implies normal fetal blood flow and amber and red implies abnormal fetal blood flow. The simplicity of this approach has meant that this device can now be used by healthcare workers at the primary level of care, without the need for a specialist.

A common approach used to evaluate the development of a pregnant mother's unborn fetus has been the use of imaging ultrasound. With this approach, the size and shape of the fetus is used to evaluate the development of the fetus. Limited attention is currently placed on the umbilical blood flow between the pregnant mother and unborn fetus. Recent research has indicated that fetuses of the correct size (obtained from imaging ultrasound), but with impediments in the umbilical blood flow, have had developmental issues after being born and it is this latter issue that Umbiflow detects. This is considered a game-

A healthcare worker uses Umbiflow to monitor fetal blood flow.

changing development in the field that can achieve a stepwise change in South Africa and the world's stillbirth statistics.

By identifying at-risk unborn fetuses at an early stage with the Umbiflow system, proactive approaches can be implemented to prevent longer term developmental issues, which extend after the baby is born and further on into adulthood. These early stage interventions would lead to positive economic benefits.

In addition, the Umbiflow system has been shown to reduce the stillbirth rate by 50% during clinical trials in the Tshwane Trial in Mamelodi. Subsequent clinical trials throughout the nine provinces in South Africa have shown a similar prevalence in stillbirth rate reduction and a large World Health Organization study has also been conducted in Ghana, India, Kenya and Rwanda. In total, over 18 000 patients have been tested under the clinical trial.

The University of Pretoria and the South African Medical Research Council have launched a programme called "Umbi Baby" in which fetuses that otherwise may have become a stillbirth statistic are tracked into their early years. This programme is revealing interesting and useful clinical information that shows that the development of a child through childhood and even into adulthood can be affected by the kind of restrictions in umbilical blood flow that the Umbiflow system detects. Interventions in these early years can then be applied proactively, thereby greatly extending the impact made by the system.

IMPACT OF THE UMBIFLOW

- Device can be used by primary care healthcare workers.
- Significant reduction in cost.
- Fifty per cent reduction in stillbirths in clinical trials.
- Early stage intervention leads to positive economic benefits.

ADDRESSING A BURNING ISSUE – WITH A WORLD-FIRST

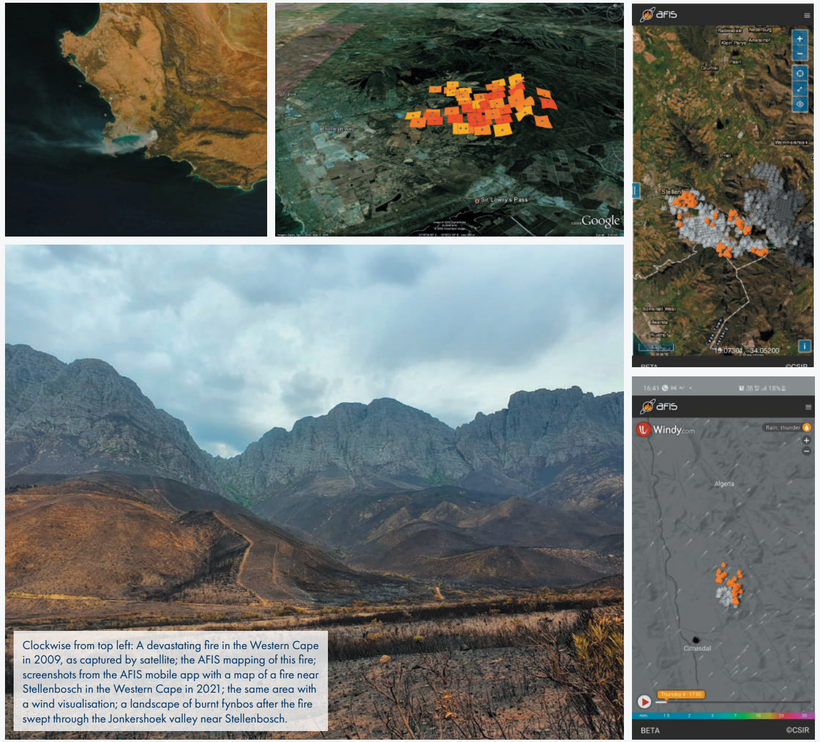
COLLABORATION TO FIGHT WILDFIRES AND MITIGATE FIRE DAMAGE

Sub-Saharan Africa has the highest frequency of wildfires in the world. While wildfires are a natural phenomenon, most fires are man-made, often with devastating consequences. During dry seasons in South Africa, fires account for costly damage to human life and settlements, infrastructure, land cover, stock and game.

During the early 2000s, the CSIR used its expertise in remote sensing and mobile technology to create the Advanced Fire Information System (AFIS) a unique, world-first system that detects fires, sends out automatic fire warnings, assesses burnt areas and provides five-day fire danger forecasts.

Since its inception, AFIS has grown into an easily accessible and globally used system that provides accurate and immediate fire information. South Africa's state-owned electricity utility, Eskom, for instance, uses AFIS to respond in time to protect its vast network of high-voltage transmission and distribution lines (approximately 50 000 km and 36 000 km, respectively) and prevent power outages and equipment damage.

A multimillion rand grant from the Department of Agriculture in 2004 enabled the CSIR to purchase a Moderate Resolution Imaging



Clockwise from top left: A devastating fire in the Western Cape in 2009, as captured by satellite; the AFIS mapping of this fire; screenshots from the AFIS mobile app with a map of a fire near Stellenbosch in the Western Cape in 2021; the same area with a wind visualisation; a landscape of burnt fynbos after the fire swept through the Jonkershoek valley near Stellenbosch.

Spectroradiometer receiving and processing system. The satellite data are downloaded and processed to identify the location of each fire. Users receive the information via a web viewer, mobile application and short message service (SMS) alert. Between 2010 and 2017, the European Commission and African Union funded the CSIR's installation of AFIS field terminals in the southern African region that use C-band satellite communications to extend the transmission of fire information to southern African countries.

The addition of an SMS alert as an early upgrade to AFIS has been of great benefit to users, especially farmers, fire protection associations and Working on Fire, a national government programme that assists agencies and land owners countrywide with ground and aerial support to control wildfires. Upgrades in 2019 and 2020 to the mobile application in the Google Play Store and Apple App Store provide native mobile access to a new AFIS Viewer.

AFIS uses data from polar- and Earth-orbiting satellites. Polar-orbiting satellites (a North to South Pole orbit every 90 minutes) provide relatively high-resolution information on fires, even those as small as 50 m x 50 m, while geostationary satellites that move at the same speed as the Earth, provide a constant image over Africa and Europe every 15 minutes. The data are downloaded at receiving stations at the CSIR's Pretoria campus and the South African National Space Agency's Hartebeesthoek ground station 40 km west of Pretoria. The processed fire data and location are provided to users via the web viewer, mobile apps and SMS alerts.

The CSIR also downloads global fire data outside its reception area continuously from NASA in the United States of America and EUMETSAT (a European satellite agency). These data are combined automatically with AFIS data to provide a global service, as almost 60% of AFIS users are located outside South Africa, in countries such as Algeria, Canada, Greece, Italy, Namibia, Russia, Spain, Turkey and the USA. The majority access the service via their mobile devices. Users and stakeholders agree that collaboration is at the heart of the AFIS success story.

"CapeNature responds to an average of 120 wildfires annually. The AFIS SMS alerts are the only notification of fires in remote and inaccessible areas. CapeNature can respond immediately, minimising the response time and can often suppress fires before they become larger. The service provided by the CSIR has been exceptional."
– Dr Ernst Baard, Executive Director: Conservation Operations at CapeNature in South Africa (Correspondence to the CSIR, 4 November 2019)

FIRE MITIGATION IMPACT

- Fire danger forecasts to support preparedness and damage mitigation.
- Informed fire management decisions.
- Early warning and alerting.
- Burnt area mapping and statistics.

A simulated fire scar in a populated area between De Kelders and Pearly Beach in the Overberg region in the Western Cape. AFIS is valuable in predicting how a fire is likely to spread, assisting authorities with fire suppression strategies and determining whether evacuation may be necessary.

Riaan van den Dool, one of a team of CSIR software engineers who continuously improve the system, with users of remote AFIS terminals installed in every country in the Southern African Development Community.

PROTECTING OUR RHINO – A CALL TO COUNTER POACHING

A TECHNOLOGY PARTNER IN THE FIGHT AGAINST WILDLIFE CRIME

South Africa stands as the last stronghold for rhinos on the African continent. Despite a public outcry, public funding and fortified reserve defences to 'save the rhino', over 7 100 (known) African rhinos had been killed for their horns in the last 10 years (based on reporting by the World Wide Fund for Nature) and tens of millions of rand invested in rhino security and protection initiatives.

Poaching syndicates are well-organised and well-equipped criminal organisations with advanced technologies at their disposal. South Africa's Kruger National Park, home to the largest rhino concentration in the country, has been victim to an escalation in rhino poaching since the current crisis began in 2008.

In 2013, the CSIR partnered with the South African National Parks (SANParks) to evaluate, test and develop anti-poaching technologies, including technologies for surveillance, detection, integration, intelligence collection and shared advanced situational awareness.

A wide area surveillance system, designed with funding from the Peace Parks Foundation and developed and manufactured by the CSIR in less

than a year, was deployed at poaching hotspots in the Kruger National Park and is highly successful. Nicknamed *Meerkat* by SANParks, the system uses a Reutech Radar Systems surveillance radar and a CSIR-developed long-range camera system to detect and localise poachers, as well as discriminate them from animals. The system is optimised to operate in the undulating bush savannah environment, in any weather, during day or night. It has been integrated with existing capabilities, staff and procedures in the park since 2017.

By 2020, Meerkat had detected more than **95%** of the poachers who entered the deployment area, contributed to the successful arrest of at least **65%** of all detected poaching groups and effectively prevented an additional **10%** of detected poachers from shooting rhinos – a total disruption of approximately **80%** of all detected poaching activity. As a result of these successes, poaching attempts in the area of operation were greatly reduced. In addition to reducing rhino poaching by almost 80%, the presence of Meerkat has deterred poachers and stabilised areas with high rhino poaching density.

The technology could be used in a conservation role in future to better understand animal behaviour. The ultimate goal is to deploy a fully autonomous surveillance system that protects wide swathes of the country's valuable natural resources at significantly reduced operating costs.

Another CSIR anti-poaching innovation is Cmore, an advanced situation awareness and decision-support platform that exploits modern web and mobile technologies to create shared awareness among users. Using real-time analytics, the system consolidates information from various sensors and external systems, which enables collaboration between multiple parties from various domains.

Clockwise from top: Tactical counter-poaching teams prepare for departure in response to threats being detected. CSIR Chief Executive Officer Dr Sibusiso Sibisi is welcomed to the Kruger National Parks by the Head of Special Projects for the South African National Parks Board, General (retired) Johan Jooste. South Africa stands as the last stronghold for rhinos on the African continent.

The SANParks Mission Area Joint Operations Centre uses Cmore to plan and run anti-poaching operations. Cmore currently covers about 50% of the rhino population in South Africa, with limited participation from Mozambique and Namibia. These efforts will be replicated within the Southern African Development Community for conservation groups and partners to create a local, regional and ultimately a global view of conservation. More than 77 organisations are registered users of the Cmore system as a result of the successes achieved in the Kruger National Park.

The CSIR also partnered with StopRhinoPoaching.com, a leader in counter-poaching efforts in southern Africa, and Seecrypt, a provider of encryption technologies for ultra-sensitive to secret voice and messaging applications, to combat wildlife crime and deliver military-grade secure communications to counter-poaching groups. The CSIR has customised Seecrypt's encryption technology, which is currently being used by various groups in counter-poaching activities.

The CSIR/SANParks/Peace Parks Foundation partnership is testing unmanned aerial vehicles (UAVs) to determine their application in counter-poaching and environmental asset protection operations. The CSIR applied knowledge gained from the defence environment to determine how UAVs can enhance the current arsenal of counter-poaching technologies and capabilities within SANParks. This includes reconnaissance and deterrence, as well as searching for, locating, tracking and following suspected poachers before and directly after an incident.

The CSIR will continue to support SANParks in the testing and evaluation of proposed unmanned aerial systems for use in environmental asset management and protection operations.

IMPACT ON MITIGATING WILDLIFE CRIME

- Shared awareness among users.
- Collaboration from multiple parties from various domains.
- Real-time situation reporting.
- Improved anti-poaching patrol planning.

CSIR researchers developed a predictive modelling tool to assist SANParks with more informed decision-making, such as in directing rangers and deploying technologies such as radar, perimeter surveillance systems and other sensors used to detect poachers more effectively.

A CSIR-developed long-range surveillance system has been used with great success in the Kruger National Park in the fight against rhino poaching.

Commercial-scale production of reagent enzyme.

FIGHTING A PANDEMIC – PCR COVID-19 DIAGNOSTIC TESTING

GREENLIGHT FOR LOCAL MANUFACTURE OF DIAGNOSTIC TEST KIT

Worldwide, the effects of the coronavirus pandemic have left an indelible mark on all walks of life. In many instances, the coronavirus pandemic has devastated people's livelihoods, their health and food systems.

Since the start of the pandemic at the beginning of 2020, South Africa relied on imported diagnostic kits and instruments. However, as the country continued to experience the devastating effects of increasingly infectious variants of the virus, with seemingly no end in sight, the need for affordable and readily available rapid testing, without dependencies on international supply chains, became critically important.

In response to this demand, the CSIR and CapeBio developed and demonstrated the efficiency of a biomanufacturing process that produces two enzymes for combination into a one-step Covid-19 diagnostic assay. The research team could capitalise on the CSIR's existing know-how and previously commercialised enzyme biomanufacturing technologies. The resulting kit and reagents to test for Covid-19 were developed in under a year as a first in South Africa.

Funded by the Department of Science and Innovation, South African Medical Research Council and Technology Innovation Agency, the innovation enables a faster response to active case finding, quarantine and contact tracing and assisting health authorities to better manage and monitor the spread of SARS-CoV-2.

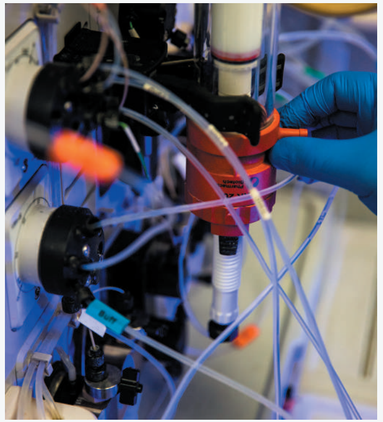
The South African Health Products Regulatory Authority approved the manufacture of the Covid-19 testing kits in July 2021.

"This is a significant breakthrough that confirms the importance of collaborative work between the public and private sectors to fast-track the roll-out and uptake of South African technologies. The combination of the CSIR's research and development infrastructure and expertise and CapeBio's capability contributed to the successful production of rapid Covid-19 testing and the improved ability of government and health authorities to manage the spread of the virus locally." – CSIR principal investigator for the project, Dr Lusisizwe Kwezi (CSIR media statement, 16 August 2021).

CapeBio started the industrial scale manufacturing of the Covid-19 test kits at its Centurion facilities in August 2021 and the kits were available in the market shortly thereafter. At full operational capacity – and if required – the firm plans to produce up to 5 000 kits daily, with 1 000 tests per kit.

IMPACT OF COVID-19 TEST KIT

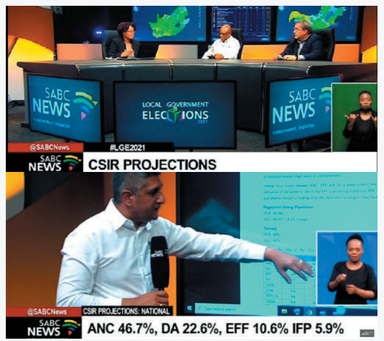
- Faster response with active case finding, quarantine and contract tracing.
- Support for health authorities to manage and monitor the spread of SARS-CoV-2.
- Sufficient industrial-scale manufacturing capacity to support vaccination programme.



Downstream purification of enzymes at scale.

DID YOU KNOW THAT ...

...the CSIR developed a model to predict the results of an election? The organisation's predictions have typically been correct to within 1% of the final result, with only 5% percent of the voting stations counted. The CSIR first used the tool in the 1999 general elections and have since used it in 10 elections. In the 2016 municipal elections, the CSIR came to within a percentage point of predicting the final ANC tally of 48.9% correctly and, in the 2021 municipal elections, the CSIR again came to within 1% of the final ANC national support of 46.1%. With this statistical capability, the CSIR has helped many clients with decision-making. For example, the organisation helped Eskom with electricity demand forecasting and government with the positioning of key facilities that fulfill the present and future needs of a community.

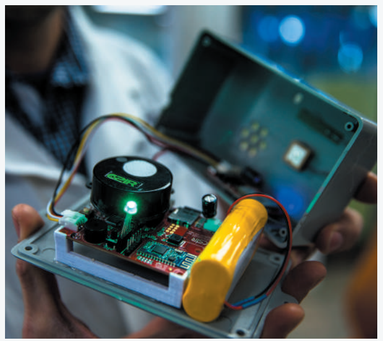


...the CSIR's Neighbourhood Planning and Design Guide has been the leading guide on human settlement planning and design for more than 20 years? *The Red Book*, published in 2019, provides practical information on the planning and design of the services and infrastructure needed for neighbourhood development, and promotes sound urban planning and design principles. It covers everything from layout, water supply, sanitation and storm water management, to electrical energy, roads and transport, public open space, as well as housing and crime prevention through environmental design. The previous edition was published in 2000.

...the CSIR contributed to a decade's information on the country's logistics costs and efficiency by compiling 10 State of Logistics™ surveys for South Africa, between 2004 and 2014? Logistics remains a key consideration in South Africa's competitiveness. The CSIR undertakes research to enhance the performance of national and regional logistics and supply chain systems, with a specific focus on fourth industrial revolution technologies.

...the CSIR has developed the first text-to-speech product that can deliver synthetic voices in all 11 of South Africa's official languages? Since 2002, CSIR researchers have been developing capabilities to work with resource-scarce languages and adapt state-of-the-art text-to-speech techniques for the South African context. The technology helps government and businesses to overcome language barriers and reach a wider audience.

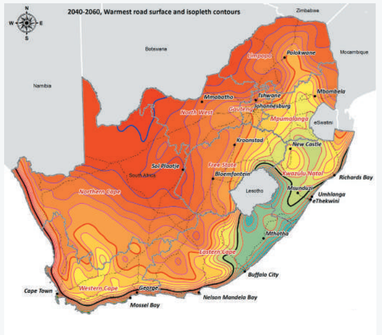
...the CSIR has developed devices that can monitor airborne transmission risk in public facilities? Since people breathe out carbon dioxide, which is then rebreathed by others, the level of carbon dioxide in the air can be used as a proxy for the risk of exposure to airborne pathogens that infect people. The devices have been installed in numerous public health facilities in South Africa. They provide quality assurance officers, infection control managers and health officials with real-time data and trends to improve operational and infrastructural interventions.



...the CSIR has been collecting wave data since 1977, when the first wave-recording buoy was deployed at the Slangkop station off Cape Point in the Western Cape? Data on wave, wind and currents are key components in an integrated port operation support system that the CSIR developed for the Transnet National Ports Authority of South Africa, which operates the country's major ports in Cape Town, Durban, East London, Gqeberha, Mossel Bay, Ngqura, Richards Bay and Saldanha Bay. These ports, and their efficient operation, are crucial to the South African economy. The smooth movement of goods leaving the country contributes to a flourishing and competitive export industry, while goods entering the country are often an important component of successful local businesses. But managing these ports is complex, with maritime traffic from around the world loading and unloading cargo in an environment affected by waves, wind and currents. The CSIR's partnership with the ports authority spans more than four decades.

DID YOU KNOW THAT ...

...the CSIR developed South Africa's first comprehensive national oceans information management system (OCIMS)? South Africa's maritime compliance and enforcement agencies have used OCIMS to investigate cases and convict perpetrators for illegal fishing in South Africa's marine protected areas. The system's eight decision-support tools enable integrated vessel tracking, harmful algal bloom detection, coastal flood hazard monitoring, operations at sea, bilge dump detection, fisheries, water quality monitoring and marine spatial planning.



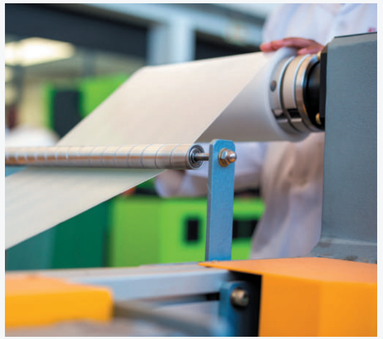
...CSIR researchers investigated the effect of climate change on road pavement temperatures over 80 years, using historic data and climate model projections? The study will assist road builders to select the right materials for construction, taking into account South Africa's changing climate and varying climatic zones. The research will inform specifications contained in the country's national standards for asphalt road pavements.

...the CSIR and its partners found that the crop load of an apple orchard has a very low impact on orchard water requirements? Instead, tree canopy size is the major driver of water use, making canopy management extremely important in the drive to produce high apple yields without using excessive amounts of water. The CSIR continues to play a leading role in crop water management through constantly improving and creating models that predict the water use of agricultural crops and improve the overall agricultural water management in a water-scarce country.

Photo: Frans Dely, 2010

...the CSIR helped to plan the air defence for the 2010 Soccer World Cup? The Fédération Internationale de Football Association (FIFA) required protection from intruders for all the stadiums and surrounding airspace in South Africa. This task was assigned to the South African National Defence Force. The CSIR assisted by using modelling and simulation to study the optimal positioning of radars and sensors, the potential flight paths of air threats and defensive patrols to complement the ground-based sensor coverage, and respond rapidly to threats.

...the CSIR developed a local polymer to replace imported polymers to coat steel pipes? One of Africa's largest steel pipe manufacturers, Hall Longmore, approached the CSIR for help because fluctuations in the exchange rate made it difficult to budget for the imported product. The CSIR relied on its expertise in polymers and composites, as well as specialised infrastructure at its Nanomaterials Industrial Development Facility, to develop the uniquely formulated polymer composite material.



...the CSIR has developed a bioplastic technology for producing fully biodegradable and compostable plastic? Products such as agricultural mulch films can be made from this material and will biodegrade within 180 days in soil conditions. At the end of its useful life, the biobased polymer is biologically transformed by micro-organisms into soil-enriching biomass, water and carbon dioxide, leaving no toxic residues.

The CSIR's Dr Abel Ramoelo discusses the use of Earth observation science for vegetation cover with students from the University of Limpopo.

OUR PARTNERS – TAKING THE LONG ROAD, TOGETHER

"It is in the long history of humankind (and animal kind, too) that those who learned to collaborate and improvise most effectively have prevailed."
– Charles Darwin, *Origin of Species (1859)*

Since its inception in 1945, the CSIR's partnerships and collaborations have been a mainstay of organisational growth and impact. Our mandate encourages cooperation with private and public sector entities, locally and abroad, to foster industrial and scientific development.

Wide collaboration in the scientific community is a trusted friend and tried and tested path towards greater creativity, rapid learning and access to networks, experts and knowledge. Partnerships, collaboration, alliances and teamwork are as integral to our success as our people, infrastructure and funding.

Over the years, collaboration has spurred the pace of innovation and the drive to adapt shared knowledge to local conditions. With the rapid advances in technologies and emergence of high-speciality areas, the pooling and transfer of skills have been critical to the CSIR's ability to respond effectively to national priorities and client needs. Today, such collaboration is more important than ever before.

In 1975, the success of South Africa's participation in the programmes of the International Council of Scientific Unions (ICSU) saw the formation of an independent Cooperative Scientific Programmes unit within the CSIR, independent of ICSU. Three years later, by 1978, almost 800 individual researchers from 80 South African research organisations were actively involved in cooperative scientific programmes across a wide range of areas. These included Earth sciences, Antarctic research and marine, weather, climate and atmospheric sciences, as well as remote sensing, ecosystems, materials, microelectronics, biotechnology, aquaculture and energy.

Opportunities to work with renowned **scientists from around the world** also presented themselves through collaborative research projects funded by international foundations, such as the Grand Challenges in Global Health, established by the Bill and Melinda Gates Foundation in 2003. This resulted in the CSIR's participation in the Africa Biofortified Sorghum project, for which researchers from around the world pooled their knowledge to create a single staple plant that offers a range of optimal, bio-available nutrients.

South Africa's long-standing cooperation with the European Union created opportunities for CSIR researchers to participate in the European Commission's framework programmes. Since inception in 1984, these programmes have funded many **international projects**. Following a bilateral agreement in 1996, the CSIR has collaborated on cyberinfrastructure with peers from India and Brazil; biofuel production with Indonesia, Austria and Sweden; flutter-free aircraft with Germany and Sweden; laser metal deposition with Germany and the United Kingdom (UK); and the interface between biodiversity and livelihoods with Costa Rica, India, Italy, the Netherlands, Sweden, the UK and Vietnam.

International collaboration continues as a mainstay in helping to solve complex challenges, such as waste management. The CSIR is cooperating with the European Commission and the African Union to recycle and recover raw materials from solid waste. Between 2018 and 2020, the CSIR's Prof. Linda Godrey joined a group of international experts who modelled global plastic flows and stocks to develop an evidence-based strategy towards the near-zero leakage of plastics into global oceans. Partners included the US- and UK-based Pew Charitable Trusts, Ellen MacArthur Foundation, Common Seas, the Universities of Oxford and Leeds, and SYSTEMIQ. The CSIR represented African interests and data. The resulting paper, 'Evaluating scenarios towards zero plastic pollution', was published in the respected journal, *Science (see overleaf)*.

Interaction with peer organisations worldwide often resulted in formal business relationships, such as those with, *inter alia*, TNO, the Netherlands organisation for applied scientific research; CNRS, the French National Centre for Scientific Research; the Research Institute of Sweden; the National Institute of Standards and Technology in the United States of America; the Danish Technological Institute; the Australian Commonwealth Scientific and Industrial Research Organisation and the Fraunhofer Gesellschaft in Germany. In addition, partnerships with multinational corporations, such as Boeing, Saab, Volvo, DaimlerChrysler, Shell, Rolls-Royce, Snecma and Siemens offered opportunities for knowledge-sharing and foreign revenue.

Other international partnering examples include the UK/Europe collaboration and takeover of niche engineering consultancy, Quo-Tec, and a joint venture in Australia with Perth-based mining consultants, Snowden Associates. And jointly, with eight other CSIR-sister organisations from around the world, we formed the Global Research Alliance in August 2002, chaired by CSIR India.

Representatives from nine leading science and technology institutions from around the world met in New Delhi, India to establish the Global Research Alliance.

The first CSIR President's lecture on 31 October 2002 featured one of India's most acclaimed information technology personalities, Dr Vijay Bhatkar, who shared India's successes in this domain. He was welcomed by Sello Matsabu, CSIR *icomtek* Director, and Dr Sibusiso Sibisi, CSIR President.

COLLABORATING ACROSS THE GLOBAL SCIENCE SCENE

PUBLISHING WORLD-CLASS SCIENCE

In a study published in *Nature Genetics* in 2018, a team of scientists from the University of Cape Town (UCT) and the CSIR, detailed – for the first time – the mechanism of how the immune system remembers prior exposures to, for example, pathogens, to trigger the right response to reinfection. First author Dr Stephanie Fanucchi (below, right) and second author Ezio Fok, at the time a CSIR-based PhD student from UCT, worked with international collaborators from **China, Germany, Italy, Singapore and the United States of America**.

GENETICS

WASTE RESEARCH

CSIR principal researcher Prof. Linda Godfrey co-authored a paper, 'Evaluating scenarios towards zero plastic pollution', with authors from the **United States of America, the United Kingdom, Austria, Switzerland, Italy and Canada**. The paper was published in *Science* in 2020. The CSIR has since partnered with The Pew Charitable Trusts, Oxford University and the South African plastics sector to pilot the application of the model in South Africa.

CSIR chief researcher Prof. Suprakas Ray's passion for research in nanoscience has earned him a formidable reputation in nanotechnology. He has authored or co-authored more than 475 articles in high-impact international journals and is one of the most highly cited authors in the field of polymer nanocomposite materials. His research has enabled him to work with peers from around the world, notably **Canada, Japan, China and India.**

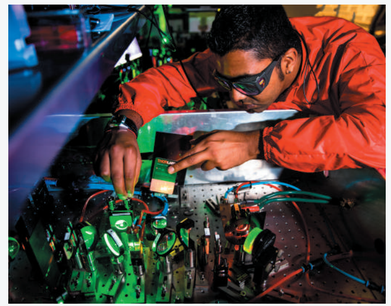
NANOSCIENCE

CELL BIOLOGY

Former CSIR Fellow Dr Colin Kenyon, worked with researchers from **Ireland** to elucidate the structure of a bacterial cell membrane enzyme. He contributed to the article, 'Crystal structure of the integral membrane diacylglycerol kinase', published in *Nature* in 2013.

CSIR principal researcher Dr Darryl Naidoo is one of the foremost beam-shaping experts in the country. Laser beam-shaping is the redistribution of a beam of laser light from one shape to another and can be applied inside or outside a laser system to improve laser performance to the application at hand. It is similar to adding a supercharger to a car engine to enhance overall performance. His research focuses on high laser power and has resulted in two *Nature* publications and several high-profile publications in the world's top photonics journals, in collaboration with Wits University.

PHOTONICS



EARTH OBSERVATION

In recent years, CSIR experts in Earth observation, led by CSIR chief researcher Prof. Moses Cho, and their counterparts in various countries, including **Belgium, Canada and the United States of America**, have authored several papers in leading international remote sensing journals, including Remote Sensing of Environment. The team, in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit and EFTAS Fernerkundung Technologiestranfer GmbH in **Germany**, has developed a bush information system for mapping bush encroachment and woody biomass in southern Africa by combining several remote sensing technologies, such as hyperspectral, synthetic aperture radar and lidar sensing. This work has enhanced South Africa's ability to respond to the impact of environmental change.

COLLABORATION ON AFRICAN SOIL

From the late 1980s, the CSIR's positioning statement – *Your Technology Partner* – reinforced our emphasis on partnerships, specifically to support national and market sector priorities.

In later years, after 2010, the CSIR was encouraged to provide specialised support to **state-owned entities** as part of the drive towards national economic development and collaboration. A Transnet/CSIR partnership, for instance, saw the state-owned entity move its research and development (R&D) facilities to the CSIR's Scientia site in Pretoria, while it continued to invest in the coastal engineering and ports infrastructure facilities in Stellenbosch.

The CSIR is a proud partner of various **government departments**, including its major stakeholder, the Department of Science and Innovation and others, such as the departments tasked with health, defence, energy, agriculture, environmental affairs, trade, industry and competition, and transport. The CSIR's work, through these partnerships, contributes to the objectives of the National Development Plan. Specific areas include the exploitation of new sources of economic growth; improved competitiveness for existing industries and firms; development of small, medium and micro enterprises; grassroots innovation; service delivery support; improved government decision-making; and innovation for environmental sustainability.

The CSIR's commitment to collaborating with **higher education institutions** stems from its early days. Our first policy guideline in 1945 stipulated fostering research in universities through grants and bursaries and cooperating with universities to create conditions in which we could offer the best science students a reasonable livelihood in scientific research. For a large part of its history, the CSIR administrated university research grants. In 1984, the CSIR Foundation for Research Development was established to support self-initiated research and build centres of excellence around gifted individuals.

Bursaries for full-time postdoctoral studies through South African universities started in 1971 and have continued in different formats over the years. Since 2003, the CSIR has worked with universities in a scholarship programme to develop high-level scarce skills in science and technology and help top students in this field to reach their full potential.

Going forward, the CSIR will continue to expand and deepen its collaboration with higher education institutions, as well as the country's Sector Education and Training Authorities, to further entrench these relationships to support national imperatives.

The New Partnership for Africa's Development, adopted by the Organisation of African Unity in August 2001, offered many opportunities for the CSIR to contribute towards development on the **African continent**.

In 2014, the region's commitment to Agenda 2063 saw African Heads of State and decision-makers emphasise the importance of science, technology and innovation as key enablers in promoting the ability of African countries to achieve their economic transformation and socioeconomic development goals. The Science, Technology and Innovation Strategy for Africa (STISA-2024) is the first of the Agenda 2063 10-year incremental phasing strategies to respond to the demand for science, technology and innovation. This response will impact critical sectors in the region, such as agriculture, energy, environment, health, infrastructure development, mining, security and water. This collective commitment and shared understanding support and enable the CSIR's contributions. Read more about our work with and for Africa on page 165.

Collaboration remains centre stage as South Africa prepares to adopt fourth industrial revolution technologies. In 2019, the CSIR became the host of South Africa's Centre for the Fourth Industrial Revolution (C4IR South Africa), a platform to bring together government departments, state entities, big business, dynamic startups, civil society, academia and expertise in the C4IR global network, to work together in adopting 4IR technologies. The centre has conducted a workshop to identify key data policy issues within the South African context and is developing a data policy framework to support the African Continental Free Trade Area. Other technology areas include Internet of Things and urban transformation; blockchain and digital assets; and artificial intelligence and machine learning.

Ultimately, the CSIR has always drawn from and contributed to the collective capabilities, expertise and knowledge of Team Science South Africa and our networks throughout the international science community. Our ability to continue along this trajectory as we step into the world of new digital realities will determine how effectively we address complex R&D challenges and fulfil our mandate to improve the well-being of all South Africans.

"We look forward to a progressive working relationship with all our partners and stakeholders as we use science, technology and innovation to support the response of a capable state to the triple challenge of unemployment, poverty and inequality to improve the well-being of all South Africans holistically and comprehensively."
– Dr Thulani Dlamini, CSIR Chief Executive Officer, CSIR Strategic Overview 2020.

Collaborating for connectivity. In 2018, the Independent Communications Authority of South Africa (ICASA) gazetted a position paper to open up television whitespaces (TVWS) for commercial use, as well as regulations for the commercial use of TVWS. This was made possible by the CSIR's earlier development of a smart spectrum management tool, the geo-location spectrum database. From left, are the CSIR's Dr Fisseha Mekuria, Seani Rananga and Dr Luzango Mfupe, ICASA's Bomkazi Somdyala and Dr Moshe Masonto, CSIR.

PARTNERSHIPS – SOME HIGHLIGHTS

"If you want the cooperation of humans around you, you must make them feel they are important – and you do that by being genuine and humble." – Dr Nelson Mandela, 2001

PARTNERING FOR THE ENVIRONMENT

COLLABORATING FOR BIODIVERSITY: THE CSIR AND THE SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE

The CSIR has a rich history of working with the South African National Biodiversity Institute (SANBI) as part of its mandate to monitor the status of South Africa's biodiversity. CSIR researchers have been making a valuable contribution to the SANBI-led National Biodiversity Assessments, undertaken every five to seven years. It details the key pressures (habitat loss, flow modification, pollution and climate change), and ecological condition, as well as headline indicators on the threat status and protection level of the country's ecosystems and species to inform policy and societal behavioural change. CSIR inputs to the first national assessment of 2004 included primarily rivers, while the assessments of 2011 and 2018 included freshwater (rivers and inland wetlands) and estuaries, generated under the leadership of the CSIR. The two most recent assessments showed that both realms are severely threatened and poorly protected.

In 2011, Deputy Minister of Water and Environmental Affairs Rejoice Mabudafhasi (left) launched the first National Freshwater Priority Areas atlas that maps South Africa's river, wetland and estuary priorities. The project partners included the CSIR, SANBI, Water Research Commission, World Wide Fund for Nature, Department of Water Affairs, Department of Environmental Affairs, South African Institute for Aquatic Biodiversity and SANParks. Holding copies of the atlas are project leader and CSIR principal scientist Dr Jeanne Nel (right) and SANBI Chief Executive Officer Dr Tanya Abrahamse. CSIR researchers Drs Lara van Niekerk, Heidi van Deventer and Lindie Smith-Adao were part of the research team.

PARTNERING TO MAKE OUR DEFENDERS SMART BUYERS AND USERS OF TECHNOLOGY

SAFEGUARDING OUR PEOPLE, PLACE AND PLANET: THE CSIR AND THE SOUTH AFRICAN NATIONAL DEFENCE FORCE

The CSIR's partnership with the South African National Defence Force (SANDF) is arguably one of the organisation's longest standing relationships. When Britain transferred radar technology to our shores in 1939, just before the Second World War, it was the birth of a world-class military radar capability in South Africa that would become the cornerstone of radio-frequency science and technology at the CSIR. The leader of the South African wartime radar group, Sir Basil Schonland, was appointed as the first President of the CSIR and his radar team joined the organisation as some of the first staff members. He tirelessly promoted the importance of science and technology in the establishment, maintenance and operation of a modern military capability.

In 2019, a South African team developed a new prototype system that enhances originally fitted crew escape systems in South African Navy submarines. The safety of submariners depends on their rapid and safe escape from a stricken submarine on the seabed.

Over decades, the CSIR has been the research, development and innovation partner to the arms of service in the SANDF in support of its mission to safeguard the sovereignty of the state, its territory, natural assets and citizens. Operating as an independent defence evaluation and research partner, the CSIR has undertaken technology design and development, testing and evaluation, acquisition support, training, capability enhancement and integration.

Land-deployed forces performing border safeguarding, counter-poaching and other operations, benefited from vehicle customisation and protection against landmines, enhanced surveillance and situational awareness, as well as robust and integrated command and control and communication systems.

As a trusted partner to the defence forces, the CSIR is frequently called upon to provide support-critical requirements for Special Forces operators on sensitive missions.

In our skies, the CSIR supported the development of a well-equipped, modern and ready air power capability by performing evaluation, acquisition support, training of personnel, and testing of air frames and missiles in a suite of wind tunnels.

Working with the South African Navy, the CSIR developed cutting-edge tracking radar systems, sonar systems, customised marine craft, and crew survivability solutions.

As the theatre of war moved to include cyberspace, the CSIR became part of the development of a national cybersecurity capability in government and various commercial sectors. The CSIR works closely with the SANDF's Defence Intelligence unit to strengthen its cyberdefence capabilities. The CSIR can also support personal identity management, as well as the safe management of extensive information and communication infrastructure.

PARTNERING FOR COMPETITIVE INDUSTRIES

The CSIR's mandate inextricably ties the organisation to South African industry. In the organisation's 75-year history, its collaboration with thousands of companies has added immeasurable value. In submitting the Draft Bill for the establishment of the CSIR to acting Prime Minister J H Hofmeyr, Sir Basil Schonland had emphasised that the development of industrial research should be regarded as "an increasingly important side of scientific research basic to the proper development of industry and efficiency of manufacturing processes". By 1984, many of the CSIR's operational units served one or more of the country's industrial sectors and approximately 2 500 research and development contracts were undertaken annually on behalf of industry. The format of the collaboration, the type of industries and the technologies employed, have evolved radically over time.

COLLABORATING FOR A COMPETITIVE LEATHER INDUSTRY

Initially, four industrial research institutes had been established under an industrial research association scheme introduced by the CSIR. They were the Leather Industries Research Institute, the Fishing Industry Research Institute, the Paint Industries Research Institute and the Sugar Milling Research Institute. The Leather Industries Research Institute became the first industrial research institute to be registered under the CSIR scheme in 1947. It was one of the pioneers of organised industrial research in South Africa. It made an effective contribution to the solution of problems affecting all aspects of the leather industry – from the processing of raw materials to the production of finished products, such as footwear. The 25th anniversary of leather research in South Africa was commemorated in 1966. In congratulating the institute, the President of the CSIR, Dr Meiring Naudé, outlined the growth of the institute from its early beginnings in the Chemistry Department of Rhodes University College under Prof. W F Barker,who personally collected the first 'research fund', totaling £30, from the tanning companies. In 1941, it became a research institute of Rhodes University College and, in 1947, it was reconstituted under the research association scheme of the CSIR and registered as an autonomous, non-profit company. By 1966, it had grown into a research institute with a worldwide reputation and an annual income of R112 000.

Seventeen women from Rhodes University had volunteered to walk seven miles along the main road between Port Elizabeth (now Gqeberha) and Grahamstown (now Makhanda) in stiletto-heel shoes to help with tests being carried out by the Leather Industries Research Institute. They each received a pair of shoes and one pound for their effort. *Port Elizabeth Herald*, 28 May 1960.

PARTNERING ON THE LASER FRONT

The CSIR has a sound track record – dating back to the establishment of the CSIR National Laser Centre in 2000 – of developing and customising laser-based technologies to improve the efficiency and competitiveness of industry players.

The organisation has collaborated with numerous prominent South African industry players on laser-based manufacturing technologies, including laser cutting, laser welding, laser cladding or laser-assisted metal deposition. The CSIR drew on its skills in laser cladding to assist ArcelorMittal to increase the life of foot rolls used in steelmaking, and MAN Energy Solutions and Eskom to repair turbine rotors used in power generation and petro-chemical industries. CSIR and Eskom welding engineers joined forces to develop a laser beam-welding and leak-sealing technology, which was later patented, to repair leaking water vessels at Koeberg Power Station, without having to drain them before conducting the repair work. At the time, Eskom's nuclear spokesperson, Tony Stott, said, "The success of the project is attributed to the continued dedication of the CSIR and the sound partnership with Eskom."

Drawing on advances in additive manufacturing at the start of the twenty-first century, the CSIR and Aerosud, an aeronautical engineering and manufacturing company, jointly developed a large 3D printer for titanium parts. Research and development was driven by the need for lighter aerospace components for aircraft that would result in lower fuel consumption.

In 2017, the CSIR and Actom's Metalplus signed an agreement to collaborate on the use of fibre laser-welding technology in component repair where conventional welding methods are not suitable for the repair process.

Collaboration with small, medium and micro enterprises on the use of photonics include working with Kutleng Dynamic Electronic Systems on laser rangefinders for industrial applications and Aditiv Solutions on a low-cost metal 3D printing machine. The CSIR collaborates with Anglo American and Ivaldi to investigate how 3D printing can be used as a technology for part replacement in mining. The organisation has signed a collaboration agreement with Transnet to investigate the use of additive manufacturing in the railway sector.

A technician at MetalPlus observes the laser refurbishment of a generator rotor using a mobile laser-based refurbishment system designed and constructed by CSIR engineers. The system can repair high-value components on site and reduce metallurgical damage on an extended heat-affected zone, while offering quick turnaround times. The picture won the Science in Action category of the 2017 SA Science Lens competition.

CORRECTING DISTORTED AEROSPACE COMPONENTS

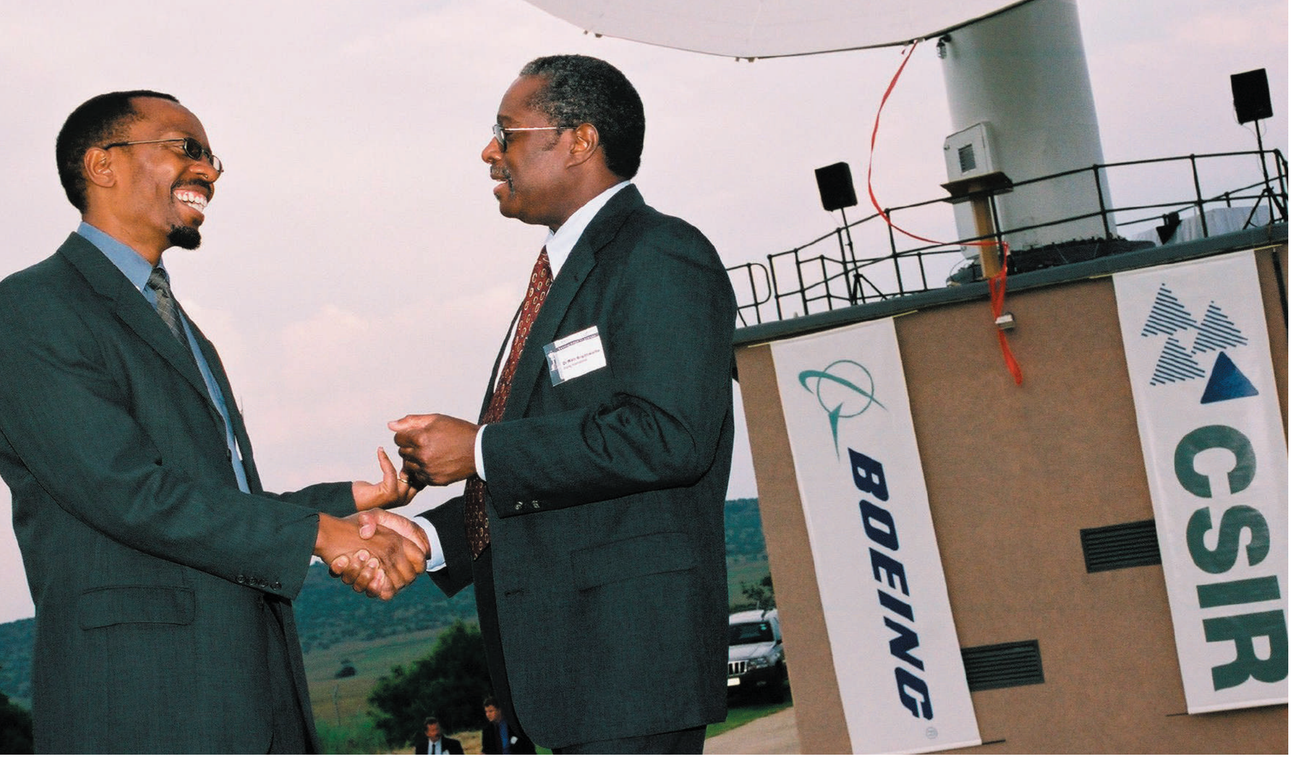
In addition to its many other applications, laser technology is also used to correct distortion in aerospace components. Denel Aeronautics manufactures a significant number of structural components for the global aerospace industry by precision machining of aluminium. One of the challenges of manufacturing thin-walled structures is the resulting post-machining distortion. Several machined components are scrapped due to this distortion problem, as the components fail the geometric tolerance specifications by being out of shape and unusable.

Facilitated by the Aerospace Industry Support Initiative, the CSIR and Denel Aeronautics used laser shock processing technology to reverse the undesirable distortion and modify the shape of the component to acceptable deviations. The photo achieved a third place in the South African Science Lens photographic competition in the category Science in Action in 2019/20.

COLLABORATING FROM THE LAB BENCH TO THE PILOT PLANT

In the last decade, the CSIR formed many close-knit relationships while helping industry to improve its competitiveness by providing access to specialised facilities and skills as part of the Industry Innovation Partnership Fund, supported by the Department of Science and Innovation. The collaboration grants enterprises access to large-scale prototyping and pre-commercial manufacturing infrastructure, equipment and expertise. Research, development and innovation activities range from laboratory-scale validation to technology prototyping and pilot manufacture. Biomanufacturing, biorefinery, nanomaterials and photonics were some of the first technologies called on in this approach to re-industrialisation.

CSIR principal technologist Dr Mike Masukume (left) and City Seokane, CEO of Clean Carbon Technologies, discuss an experimental carbon nanotubes manufacturing set up in 2017. Clean Carbon Technologies develops technology to capture carbon emission waste and convert it into carbon nanotubes. Carbon nanotubes have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. "Access to CSIR advice and mentorship is giving us this opportunity to develop the South African carbon nanotube market with the CSIR," Seokane said at the time.



CSIR President Dr Sibusiso Sibisi (left) in discussion with Dr Walt Braithwaite, President of Boeing Africa, at the inauguration of the 13 m Ka-band antenna at Hartebeesthoek in 2003. The antenna enabled the CSIR Satellite Applications Centre to provide the Boeing Company with ground support for the Spaceway constellation of satellites, used for broadband communications. With the new addition, the CSIR became one of the first ground stations globally to offer clients telemetry, tracking and command support in all the frequency bands, from L-band to Ka-band.

INTERNATIONAL PARTNERING IN THE PEACEFUL EXPLORATION OF OUTER SPACE

On 4 October 1957, history changed when the Soviet Union launched Sputnik 1 successfully as the world's first artificial satellite. And, at the southern-most tip of Africa, a group of brilliant CSIR engineers received international acclaim as the first in the world to track the spacecraft and predict its re-entry into the Earth's atmosphere.

These CSIR engineers started a proud history, which took shape when a site was acquired at Hartebeesthoek, some 50 km north-west of Johannesburg, where Africa's first hydraulically driven 12 m X/Y parabolic antenna, courtesy of the National Aeronautics and Space Administration (NASA), was installed and is still operational today. It was the start of a mushrooming 'antenna farm', that equipped South Africa to supply satellite tracking, telemetry and command (TT&C) services; and receive Earth observation data from Earth orbiting satellites.

Since tracking the first commercial communications satellite, Early Bird, and verifying its transfer into a synchronous orbit in 1964, operations at Hartebeesthoek were, above all, collaborative in their reliance on partnerships with players from around the globe. During the first 15 years of the space age, the NASA collaboration defined South Africa's space involvement. In later years, collaborations with many other international space agencies would follow. The European Space Agency for meteorological data from Metosat-1; and the French space agency, CNES for TT&C support for its geostationary satellites, launch support for an array of spacecraft and later land coverage data from the SPOT satellites. The CSIR also collaborated with the Indian Space Research Agency, the Japanese Space Agency, the Korean Space Agency and the Taiwanese Space Agency.

The CSIR Satellite Applications Centre also collaborated with large commercial space operators. These included Boeing for ground support for its Delta-IV launches, and launch support for its three Spaceway satellites; Eutelsat, for which the CSIR installed a Ku-band satellite monitoring station; and Intelsat for orbital support services, a C-band antenna system for launch support of the Intelsat-X satellite and later for Ku-band support for its satellite fleet for 10 years.

At the time of the centre's incorporation into the South African National Space Agency in 2010, Edwin Ramsey of Boeing said: "What began as a modest agreement in 1998 to cooperate in flying and testing Ku-band commercial satellites, developed into a strong partnership between the CSIR Satellite Applications Centre and Boeing's satellite mission operations team."

Celebrating collaboration: The 25 degrees South marker given to Boeing as a memento during the inauguration of the Ka-band antenna at Hartebeesthoek.

The use of biophotonics to combat cancer was the focus at a symposium of the African Laser Centre in September 2019 at the University of Johannesburg.

PARTNERING FOR AFRICA – WITH AND FOR THE PEOPLE OF OUR CONTINENT

CONTRIBUTING TO ECONOMIC GROWTH AND RAPID TRANSFORMATION IN AFRICA

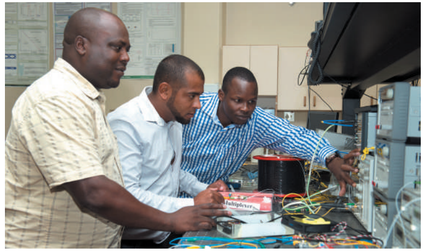
The CSIR supports the African Union's vision of an integrated, prosperous and peaceful Africa, driven by its own citizens and representing a dynamic force in the global arena. Since its early days, the organisation has been contributing to innovation in Africa to tackle continental societal challenges through cooperation in science, engineering and technology.

Recently, the CSIR joined forces with the African Union Development Agency (AUDA)-New Partnership for Africa's Development (NEPAD) and Stellenbosch University to host the AUDA-NEPAD Centre of Excellence in Science, Technology and Innovation – one of five such centres approved by the African Union. The centre serves as a platform for funding and resource acquisition and support to upscale, disseminate and localise proven innovations to African Union member states and governments. Examples include well-tested innovations from programmes at Stellenbosch University and the CSIR with proven technologies or practices ready for upscaling and commercialisation. The innovations offer a wide range of solutions to challenges in health, renewable energy, agriculture, water and sanitation in countries across Africa.

Over the years, the CSIR contributed consistently, through specialised technology fields, to developmental challenges within the region. The CSIR's African Laser Centre (ALC), established in 2002, continues to support research collaboration in **laser technology** between South Africa and the rest of Africa. Annually, the ALC facilitates about 20 collaborative research projects with applications in areas such as health, communication, manufacturing and environmental sensing.

In **biosciences**, the AUDA-NEPAD Southern African Network for Biosciences (SANBio) helps to address disease as well as food and nutrition insecurities within the Southern African Development Community (SADC). The CSIR hosts and supports the network secretariat located at its Scientia campus. Since inception in 2005, the network has supported 17 collaborative projects in food and health and produced 148 MSc, 71 PhD and 22 postdoctoral degrees at institutions of higher learning and training throughout the region, as well as 2 000 vocational trainees. This has resulted in jobs, numerous start-up companies and the transfer of products to users.

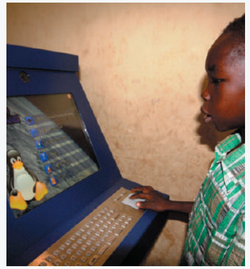
The CSIR-hosted Centre for High Performance Computing transferred skills and capabilities in **high-performance computing** for the Square Kilometre Array (SKA) to countries in Africa that host SKA antennas. Partner countries in the Very Long Baseline Interferometry network are Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia.



Collaboration in (from the top) laser technology, biosciences and high-performance computing.

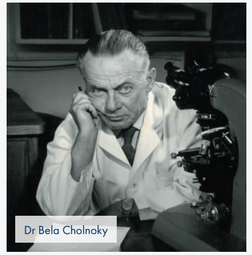
WORKING WITH, IN AND FOR AFRICA

Since its establishment, the CSIR has drawn from its multidisciplinary resources to help address Africa's unique and complex challenges and improve the quality of life of all its people. Our aim, which remains steadfast, is to use the power of science, engineering, technology and innovation as the catalyst for the continent to capitalise on opportunities for growth and development. The information on these pages maps some of the many projects through which we have worked in Africa, with its people and for its prosperity.



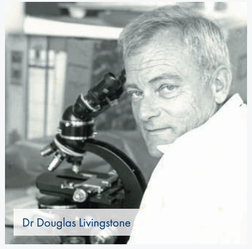
Angola	• Disaster fire monitoring • Marine and coastal research • Studies on the decommissioning of oil fields
Botswana	• Climate change reporting • Automated health helpline • Assessment of renewable energy • Dynamic spectrum sharing • Laser-based manufacturing • Water demineralisation
Cameroon	• Environmental and social impact assessments for the petroleum industry
Democratic Republic of the Congo	• Study on deposits of natural bitumen • Sustainability of hydropower of the Congo River • Mine winder rope testing
Egypt	• Point-of-care photonic crystal biosensor for HIV detection and viral load quantification • Laser-based manufacturing
Eswatini	• Cybersecurity audits • Food safety • Fire investigations
Ethiopia	• Laser technology for pollution measurement • Climate-resilient roads for rural communities
Ghana	• Food processing • Road and bridge work standards • Environmental assessment for wind energy • Alternative road surfacing • Climate-resilient roads for rural communities • Point-of-care fetal ultrasound • Fire investigations
Kenya	• Tree biotechnology for fuel wood; forest preservation • Marine and coastal research • Effluent management
Lesotho	• Improvement of computer literacy through public computer terminals • Rock material usage in construction and scale modelling for the Lesotho Highlands Scheme • Land cover change
Malawi	• Safe health waste disposal • Roads research • Aquaculture

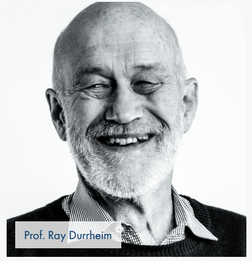
Mozambique	• Environmental impact assessment of the Mozal Aluminium Smelter • Enabling software to promote agricultural development • Diagnostics for foot-and-mouth disease • Climate-resilient roads for rural communities • Road and bridge work standard specifications • Environmental impact assessment • Transport sector studies
Namibia	• Synthetic polymers to stabilise sands for road construction • Ocean floor mapping for a new tanker berth at the Port of Walvis Bay
Nigeria	• Hydrographic survey for planning of a new access channel to Port Harcourt • Near-infrared femtosecond laser-induced bacteria inactivation • Anti-cancer and anti-inflammatory activities of medicinal plants – elucidation of molecular mechanism of action using laser-based technologies
Rwanda	• Point-of-care technology for foot-and-mouth disease • Point-of-care fetal ultrasound
Senegal	• Sustainable food processing • Risk and threat assessments in cyberspace
Seychelles	• Design verification of a proposed new marina through physical modelling
Tanzania	• Low-cost gravel road test kit for gravel road construction • Investigation of premature failure of high-volume urban roads, highways • Guidelines for asphalt in road pavements • Mine winder rope testing • Waste management
Uganda	• Development of the essential oils sector
Zambia	• Connectivity in rural communities • Diagnostics for foot-and-mouth disease • Heat tolerance screening training for mines • Aquaculture
Zimbabwe	• Performance testing of emergency breathing equipment • Geotechnical characterisation of orebodies • Pharmacogenetics • Aquaculture


Dr Bela Cholnoky


Dr Musa Mhlanga


Asanda Masangwana


Dr Douglas Livingstone


Prof. Ray Durrheim


Reyhana Mahomed

OUR PEOPLE – STRENGTH IN DIVERSITY

THE ULTIMATE INVESTMENT IN INNOVATION

Successfully meeting its mandate to improve the well-being of all South Africans requires the CSIR to rely on a critical asset – its people. In the quest to remain at the forefront of global developments in science and technology, the organisation's ultimate investment is in the men and women who apply their specialist knowledge and business acumen in pursuit of research excellence.

Over the years, the CSIR's emphasis on people development has ensured its consistent and continuous contribution to technological innovation and the generation of new knowledge. The organisation's commitment to the academic development of its staff is evident from the cadre of staff who obtain their Master's or Doctorates, annually – in 2020, 47 employees added this achievement to their resumes.

Transformation and diversity are high on the CSIR agenda. Our EPIC values of Excellence, People-centred, Integrity and Collaboration acknowledge and celebrate the passion, dedication and contributions of our people and our commitment to their growth and development.

The organisation is a level 1 broad-based black economic empowerment contributor, with recruitment strategies that focus on those who were historically under-represented in science, engineering and technology. Certainly, one of the CSIR's major achievements in South Africa's post-1994 democratic reality, is a radically transformed workforce. Today, some 66% of our science, engineering and technology staff are black and 36% are female. At leadership level, three out of the seven executive committee members are women.

Although the composition of our employees today is significantly different from that of 1994, what has remained the same is their passion for science, engineering and technology.


Dr Mamoeletsi Mosia

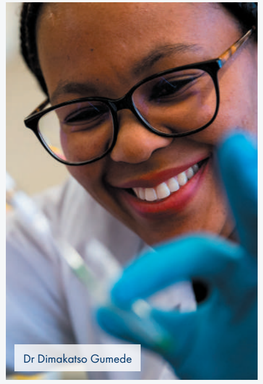

Tsepo Nkuna


Dr Stoyan Stoychev

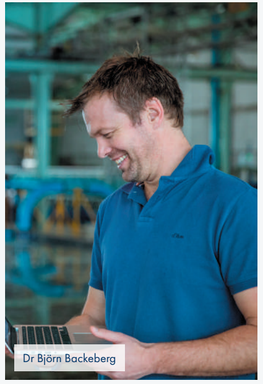

Sipho Mbhokota

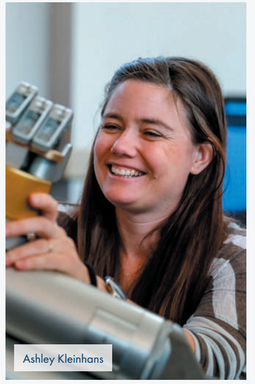

Nyalleng Moorosi


Dr Lusisizwe Kwezi


Dr Dimakatso Gumede


Charity Maepa


Dr Björn Backeberg


Ashley Kleinhans

TEAMWORK – THE POWERFUL ADVANTAGE

WORKING TOGETHER TO TOUCH LIVES THROUGH INNOVATION

"If you want to go fast, go alone. If you want to go far, go together." – African Proverb

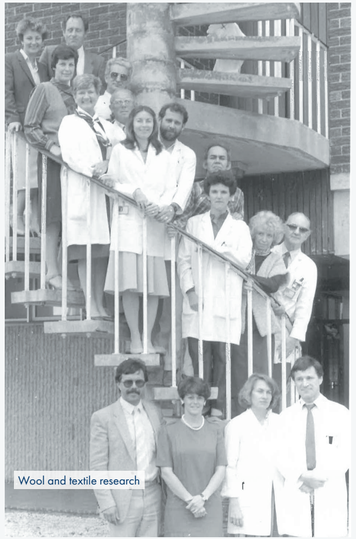
Creating a better world requires leadership, teamwork and collaboration. Ultimately, leadership is about keeping a team focused and motivated, especially when stakes are high and consequences really matter.

Teams require individual and mutual accountability to meet expectations through the contributions of their members. Effective teamwork lays the groundwork for organisational success. When individual team members rely on the team and jointly take responsibility for its achievements, the organisation is the ultimate champion.

Throughout the CSIR's history, across all its disciplines and for multiple different clients, CSIR teams have worked tirelessly to help build our organisation, support our nation, improve our industries and contribute to the well-being of all our people.

Over the years, working with clients, partners, associates, peers and colleagues, our CSIR teams have demonstrated a singular ability to deliver beyond expectation. Our teams have helped determine the optimal water use of apple orchards; assisted traditional health practitioners to develop safe and standardised traditional medicines; advised mining companies on sustainable agricultural and land-use options post mining; modelled energy solutions for remote villages far from the national utilities grid; developed guidelines for neighbourhood planning; developed a polymer composite coating solution for one of Africa's largest steel pipe manufacturers; as well as developed an online oceans and coastal system that can help spot irregular activities of vessels in our waters, detect harmful algal blooms, and map flood hazards along the coast.

We salute the men and women of the CSIR whose teamwork made our vision work.


Wool and textile research


Plant biotechnology


Tree improvement research


Mechanical rope testing


Biodiversity


Ports infrastructure


Building science


Nanocomposites


Synthetic chemistry


Water research


Nanotechnology


Media streaming technologies


Aerodynamics


Internet of Things


Laser sensing


Parliamentary liaison


Biometrics


Structural biology


Environmental impact assessment


Food safety


Laser engineering


Sensor and building science


Electronic warfare


Climate change


Unmanned aerial vehicles


ICT for accessibility


Plant biotechnology


Network emulation and simulation

ABBREVIATIONS AND ACRONYMS

AECI	African Explosives and Chemical Industries
AFIS	Advanced Fire Information System
AISI	Aerospace Industry Support Initiative
ALC	African Laser Centre
ANC	African National Congress
ARMSCOR	Armaments Corporation of South Africa
AUDA	African Union Development Agency
Bafana Bafana	South African national soccer team
BBC	British Broadcasting Corporation
C4IR South Africa	Centre for the Fourth Industrial Revolution South Africa
Caltrans	California Department of Transportation
CEO	Chief Executive Officer
ICC	International Convention Centre
CNES	Centre National d'Etudes Spatiales, France
CNRS	French National Centre for Scientific Research
CSIR	Council for Scientific and Industrial Research
COMRO	Chamber of Mines Research Organisation
cum laude	Achieved with distinction
DNA	Deoxyribonucleic acid
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EVPOP	Executive Vice-President: Operations
FRD	Foundation for Research Development
GRA	Global Research Alliance
HartRAO	Hartebeesthoek Radio Astronomy Observatory
HSRC	Human Sciences Research Council
HVS	Heavy Vehicle Simulator
ICASA	Independent Communications Authority of South Africa
ICSU	International Council of Scientific Unions
IDRC	International Development Research Centre
ITRI	Industrial Technology Research Institute
LATU	The Technological Laboratory of Uruguay
LEFPA	Lowveld and Escarpment Fire Protection Association
MDA	MacDonald, Dettwiler and Associates (formerly), MDA is Canada's largest space technology developer and manufacturer
MRC	Medical Research Council
NASA	National Aeronautics and Space Administration
NEDLAC	National Economic Development and Labour Council
NEHAWU	National Education, Health and Allied Workers' Union
NEPAD	New Partnership for Africa's Development
NIMR	National Institute for Materials Research
NMERI	National Mechanical and Engineering Research Institute
NRF	National Research Foundation
NSI	National System of Innovation
OAU	Organisation of African Unity
ORT	Optronic Radar Tracker
PCR	Polymerase chain reaction
PV	Photovoltaic
R&D	Research and development
RDI	Research, development and innovation
RSS	Reutech Radar Systems
SAAF	South African Air Force
SABITA	Southern African Bitumen Association
SABS	South African Bureau of Standards
SAC	CSIR Satellite Applications Centre
SADC	Southern African Development Community
SAIDCOR	South African Inventions Development Corporation
SANBI	South African National Biodiversity Institute
SANBio	Southern African Network for Biosciences
SANDF	South African National Defence Force
SANParks	South African National Parks
SANSA	South African National Space Agency
SARS CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SATIS	South African Technology Information Service
SERA	Southern Education and Research Alliance
SGA	Small for gestational age
SKA	Square Kilometre Array
STISA-2024	Science, Technology and Innovation Strategy for Africa 2024
SMME	Small, medium and micro enterprise
SOCCO	Southern Ocean Carbon and Climate Observatory
SRSC	Satellite Remote Sensing Centre
STADAN	Satellite Tracking and Data Acquisition Network, NASA
TfD	Technology for Development
TT&C	Tracking, telemetry and command
TVWS	Television whitespaces
WITS	University of the Witwatersrand
WWF	World Wide Fund for Nature (previously World Wildlife Fund)
UAV	Unmanned aerial vehicle
UCT	University of Cape Town
UP	University of Pretoria
WAMIS	Wide-area Monitoring and Information System
WWI/WWII	World War I/World War II
WWI OBE (Mil)	Officer of the Most Excellent Order of the British Empire (Military)
WWII CBE (Mil)	Commander of the Most Excellent Order of the British Empire (Military)

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This book contains information and images compiled from print and electronic sources, much of it obtained from the invaluable trove of historical material catalogued and stored in the CSIR Archives, and from individual contributions.

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VISUALS AND IMAGES

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Inside front and back cover: Photo collage of some of the CSIR's employees over the years

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