Nicoline Basson

PASSAGE TO PROGRESS

THE CSIR'S JOURNEY OF CHANGE 1945–1995

Passage to Progress was written to commemorate the CSIR's fiftieth anniversary celebrated in October 1995. The book takes a brief look at the dawn of technology in Africa, its subsequent progress, and the CSIR's role in its development. The main focus is on the past 15 years, with an in-depth look at the transformation processes embarked upon within the CSIR; the learning experience associated with radical change; the effects of this change in policy in terms of the organisation and its people, and the way the CSIR is fulfilling its role in a rapidly changing environment, both locally and internationally.

Created by the Government after World War II, to provide research support for South Africa's primary and secondary industries, the CSIR has adjusted its strategy according to the demands of the times. These demands varied from shifts in Government approaches and priorities prompted by political considerations, to changes in international trends, financial constraints that forced the CSIR to substantially increase its income from the private sector, and the realities of the new South Africa, which have brought the CSIR closer to the development and societal needs of southern Africa.

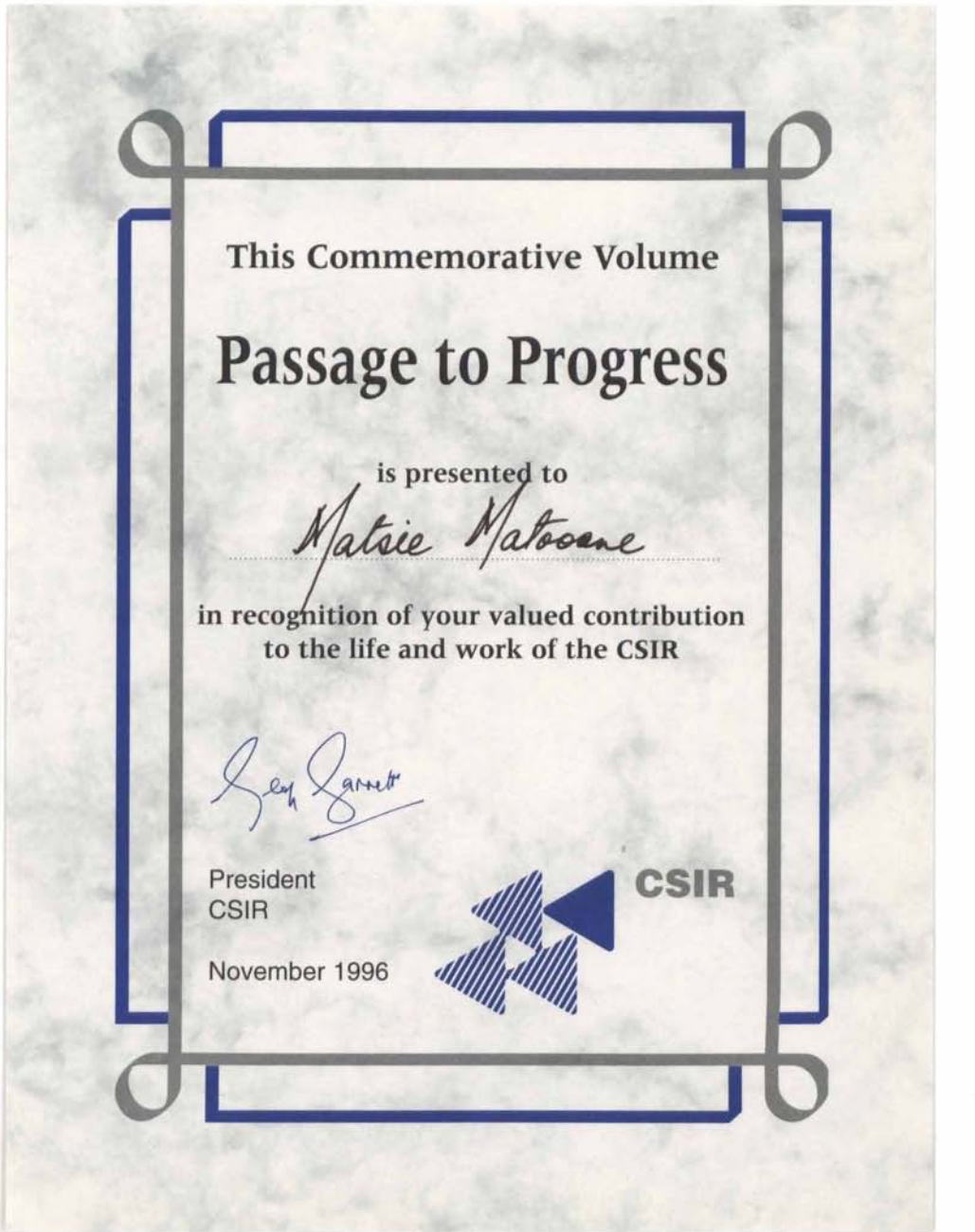
The CSIR's research and engineering capacity is the largest on the African continent. It has fifty years of experience and has functioned under three different systems of government. Over the last decade particularly, the primary mission has become the successful innovation and implementation of technology.

Passage to Progress traces the CSIR's journey of change from the 'blue skies' approach to research to the down-to-earth relevance of its present integrated role in the national science and technology strategy, which is to promote economic growth and a better quality of life for all South Africans.

Front cover photograph:
Dawn over the CSIR's headquarters
Photo: Dewald Reinders


1945 - 1995

Passage to Progress



Traveller there is no path.
Paths are made by walking.

Antonio Machado

Passage to Progress

The CSIR's Journey of Change. 1945–1995

NICOLINE BASSON

JONATHAN BALL PUBLISHERS · JOHANNESBURG

Published in 1996 by
Jonathan Ball Publishers (Pty) Ltd
P O Box 33977
Jeppestown 2043

ISBN 1 86842 034 5

Design by Michael Barnett
Typesetting and reproduction of text by Book Productions, Pretoria
Typesetting and reproduction of photo sections and cover by RT Sparhams, Johannesburg
Index by Naomi Musiker
Printed and bound by National Book Printers, Drukkery St, Goodwood, Western Cape

Contents

Acknowledgements

The contents of this book were based on key documents produced by the CSIR on policy and strategy, public speeches of present and past presidents, the minutes of Board meetings and relevant published material listed in the Bibliography towards the end of this book. This formally recorded information was supplemented by material acquired through numerous interviews and discussions with the people listed overleaf, who are either current or past employees of the CSIR, associated officially or through business with the organisation. Great care was taken to obtain as wide a range of viewpoints as possible within the time available in an attempt to ensure the credibility of this account. People willingly gave their time and their heartfelt views. It was an enriching experience to discover the common bond created by a feeling of loyalty to what the CSIR stands for, whether they agreed with the changes in course or not.

The author is deeply indebted to the many associates and friends, not mentioned by name, whose views were acquired through contact in the working and social environments over twenty years. They are responsible for the broader grassroots perspective reflected in this book. Their insight and support shaped the author's thinking and formed the foundation for the contents of the book.

Mr Bob Newman must be singled out, for, after his retirement from the CSIR, he undertook the task of compiling a list of relevant source docu-

ments to be consulted in order to produce this book. His painstaking recording of facts, informed approach to selection of material and devotion to accuracy contributed in no small way to the end product.

A special word of thanks to Dr John Vogel, who provided guidance on the fascinating subject of ancient technology and reviewed the relevant section, making invaluable comments and additions to the text. The informed assistance of Mrs Ansie Steyn (National Cultural History Museum), Dr Tim Huffmann (University of the Witwatersrand), Mrs Marie van der Ryst (Unisa), Prof. André Meyer (University of Pretoria), Dr Peter Beaumont (McGregor Museum, Kimberley) and Dr Francis Thackeray (Transvaal Museum) for the ancient technology section is much appreciated. Reviewers who gave quality time and guidance are Drs Brian Clark, Geoff Garrett, Daan Toerien, Petro Terblanche, Reinhard Arndt, Messrs Neo Moikangoa, Bob Newman, Roy Page-Shipp, Ms Mpume Ramphomane and Amie Hunter.

Finally, the author wishes to thank Jonathan Ball and Francine Blum of Jonathan Ball Publishers, and Matthew Seal, consulting editor, for adding their respective professional touches to the book.

Mr Johann Ahlers	*Director, Communications and Information Networking Technology, CSIR*
Dr Louw Alberts	*Former Chairman, CSIR Board*
Dr Francois Anderson	*CSIR Fellow, Manufacturing and Aeronautical Systems Technology, CSIR*
Dr Rein Arndt	*President, FRD*
Mrs Olga Badenhorst	*Former PA, Director, Earth, Marine and Atmospheric Science and Technology, CSIR*
Mr Alan Batchelor	*Water, Forestry and Environment Technology, CSIR*
Mr David Bath	*Director, Building Technology, CSIR*
Mr Jan Becker	*Director, Textile Technology, CSIR*
Dr Dirk Bezuidenhout	*Manufacturing and Aeronautical Systems Technology, CSIR*
Dr Reinie Biesenbach	*International Relations*
Dr Harry Booyens	*Communications and Information Networking Technology, CSIR*
Dr Willem Botha	*CSIR Fellow, Communications and Information Networking Technology CSIR*
Prof. Jimmy Bull	*Former Chief Director, CSIR*
Dr Pat Butler	*Former Chief Director, CSIR*
Mrs Mandi Calinikos	*Communications and Information Networking Technology, CSIR*
Mr Fred Camphor	*Former CSIR Executive*

Mr Alastair Chaffey	*Manufacturing and Aeronautical Systems Technology, CSIR*
Dr Brian Clark	*Former President, CSIR*
Dr Neville Comins	*Materials Science and Technology, CSIR*
Mr Gary Corderley	*Manufacturing and Aeronautical Systems Technology, CSIR*
Mr Ian Dean	*Consultant*
Mrs Elsa de Beer	*PA Executive, CSIR*
Dr Johan de Beer	*Water, Forestry and Environment Technology, CSIR*
Dr Gideon de Wet	*Corporate Policy Study Unit*
Mr Albert du Toit	*International Relations*
Dr Chris Garbers	*Former CSIR President*
Dr Geoff Garrett	*CSIR Executive/President (December 1995)*
Mr Lourens Greyvenstein	*Technifin*
Mr Mike Groch	*CSIR Executive*
Dr Eric Halliday	*Former CSIR researcher*
Dr Stewart Hart	*Materials Science and Technology, CSIR*
Mr Fred Herbst	*Former Information Research Services, CSIR*
Dr Gorra Heymann	*Former CSIR Executive*
Mrs Jo Hoffmann	*Former PA to CSIR President*
Mr Pitout Horn	*Textile Technology, CSIR*
Mr Hans Ittmann	*Information Technology, CSIR*
Mr Albert Jordaan	*CSIR Executive*
Mrs Marina Joubert	*FRD*
Dr Rivka Kfir	*Water, Forestry and Environment Technology, CSIR*
Dr Denys Kingwill	*Former Director CSIR/Author The CSIR – The First 40 Years*
Dr Leon Knoll	*Former CSIR Board Member*
Mr Dieter Krueger	*Former Director Energy Technology, CSIR*
Ms Cheryl Langbridge	*Mining Technology, CSIR*
Ms Berénice Lue	*Corporate Parliamentary Affairs/ International Relations*
Mr Tsietsi Malehu	*Corporate Communication Services*
Adm. A Malherbe	*Armscor*
Dr Hoffman Maree	*Director, Transport Technology, CSIR*
Mr Alan Marlowe	*Corporate Mining Programme*
Mr Philip Masemola	*Corporate Human Resources*
Dr Maurice McDowell	*Former Director, CSIR*
Dr Hank Miller	*Former CSIR researcher*
Mr Neo Moikangoa	*CSIR Executive*
Dr Khotse Mokhele	*FRD*

Mr Hugo Mouton	*Corporate Human Resources*
Mr Kaya Mpepo	*Materials Science and Technology, CSIR*
Dr Frank Nabarro	*CSIR Fellow, Matrials Science and Technology*
Mrs Margaret Nabarro	*Former PA to Sir Basil Schonland*
Mrs Sharda Naidoo	*Technology for Development, CSIR*
Mr André Nepgen	*Materials Science and Technology, CSIR*
Mr Bob Newman	*Former Information Research Services, CSIR*
Mr Roy Page-Shipp	*Corporate Special Projects/RDP Office*
Dr Adi Paterson	*Director Materials Science and Technology/ Executive, CSIR*
Dr Wally Prozesky	*Former CSIR Board Member*
Ms Mpume Ramphomame	*Corporate Human Resources, CSIR*
Mr Roger Roman	*Consultant*
Dr Danie Roos	*Water, Forestry and Environment, CSIR*
Mr Gerhard Smith	*Water, Forestry and Environment Technology, CSIR*
Mr Robert Speth	*Manufacturing and Aeronautical Systems Technology, CSIR*
Mrs Susan Stephan	*Former PA to CSIR President*
Mr George Stoop	*Former Editor, Information Research Services, CSIR*
Dr Albertus Strasheim	*Former Chief Director, CSIR*
Mr Johan Strydom	*Manufacturing and Aeronautical Systems Technology, CSIR*
Dr Niko Stutterheim	*Former Deputy President, CSIR*
Mr Dawid Swanepoel	*Onderstepoort Veterinary Institute Library*
Dr Petro Terblanche	*Director, Food Technology, CSIR*
Dr Daan Toerien	*Director, Manufacturing and Aeronautical Systems Technology, CSIR*
Dr Dick Turner	*CEO, National Calibration Service*
Mr Rob Urry	*Manufacturing and Aeronautical Systems Technology, CSIR*
Mr André van der Westhuysen	*FRD*
Dr Ben van Vliet	*Director, Policy Studies*
Mr JD van Zyl	*Former, Administration Services Dept, CSIR*
Dr Andries Vermeulen	*Manufacturing and Aeronautical Systems Technology, CSIR*
Mr Awie Vlok	*Building Technology, CSIR*
Dr John Vogel	*Water, Forestry and Environment Technology, CSIR*
Mrs Marge Wilkinson	*Human Resources and Services, CSIR*
Mr Pat Willis	*Mining Technology, CSIR*

Dr Graham Wright	*Materials Science and Technology, CSIR*
Mr Anthos Yannakou	*Director, Water, Forestry and Environment Technology, CSIR*

Foreword

Dr Frene Ginwala,
Speaker of the
General Assembly in Parliament
and former head of the
ANC's Research Department

The fiftieth anniversary of any institution is justifiably an occasion for the affirmation of its achievements and praise for those who contributed to them.

Coinciding as it does with the birth of a democratic South Africa, the golden anniversary of the CSIR provides the opportunity to become part of an interactive process in which all institutions in South Africa are being challenged by the very fundamental changes in the political, social, economic and cultural environment, rather than for what would have been simply a routine process of reflection and re-evaluation.

The CSIR was established amidst celebrations at the end of World War II, when the bombing of Hiroshima and Nagasaki demonstrated the awesome power of science and technology. However, that war also illustrated the perversion of scientific research to destroy human life on a previously unimaginable scale, and provided many examples of the way in which science and technology could be used to sustain oppressors in power.

Unmindful of the latter, General Smuts addressed the first formal meeting of the Council of the CSIR and said:

> *The time has come when we must tackle our own job and the problems which lie before South Africa. We must develop our own scientific handling of these problems . . . Science has come forward in gigantic strides, and more and more, everyone is beginning to feel that scientific research is a matter of vital importance. To your Council is entrusted this work.*

For most of its existence the CSIR has had to operate in a South Africa where the entire focus of development was on a minority which aspired to first world science and technology, in the midst of impoverishment and underdevelopment of the majority. There was a further distortion as the minority sought to retain itself in power and in the process used social research and technology for purposes of control and repression. Meeting the strategic interests of the minority became a priority for state-funded research. At the same time, the international credibility of institutions such as the CSIR was misused for illegal access to foreign technology, and to obtain scientific materials and equipment in violation of international sanctions. The imposition of sanctions also brought home to South Africans the importance of indigenous science and technology development.

Notwithstanding, much has been achieved by the CSIR in the past fifty years, and clearly a democratic South Africa is stronger for this heritage. Science and technology are the keys to the successful realisation of the objectives of our national reconstruction and development effort. There is a need for a reconfiguration of our scientific and technological heritage to harmonise with the times and to enable them to meet new socio-economic challenges. The future lies in innovation, and greater investment will be necessary. Accordingly, the CSIR must remain at, or close to, the frontiers of knowledge in all major areas of technology if South Africa is to meet the challenge of global industrial competition and ensure a rising standard of living for its people.

As one of the country's eight science councils, the CSIR has a pivotal role to play in ensuring that industry thrives and, more importantly, in providing access to technology for all South Africans. Its endeavours in the field of technology for development are the key to unlocking South Africa's vast and largely unexplored potential.

The CSIR has responded to the challenge facing parastatal institutions earlier and more thoroughly than most. Even before the historic political changes, it began a process of restructuring itself and readdressing its aims and programmes to take up issues which were clearly of importance to reconstruction and development. In doing this it was prepared to discuss with and listen to people who were then not in power.

In restructuring it took up the challenge of raising funds in addition to those received from government. It used strategic management planning, new information systems and a performance audit to improve efficiency. Its success sets an important example.

The CSIR is now able to provide an important service to both government and civil society. Its management and information systems are being used widely to make decision-making easier and more transparent. More of its

research is directed at meeting basic needs, with the active involvement of communities. But the problem of creating a system of customer-driven research in circumstances, where the user communities do not have resources to purchase technology, still remains.

The CSIR is not immune from the white male domination that characterises most of our institutions. A start has been made in ensuring that both the professional and administrative staff become representative. The apartheid legacy of denying mathematical and scientific training to the African population created additional difficulties and has placed special responsibilities on the science councils. These need to be proactive, providing full support for both male and female students, and effective on-the-job training.

South African parastatals are imbued with a culture of a closed secret society. The appointment and functioning of the CSIR Board, including the benefits of members, needs to be open to public scrutiny. Much remains to be done in making all operations open and transparent. However, in the CSIR, a balance will need to be struck between the democratic and constitutional obligation for accountability and transparency and the need to retain a competitive edge.

In many respects technology has become synonymous with human progress, and a relevant and viable Council for Scientific and Industrial Research is integral to our success. South Africans in all our diversity celebrate with the CSIR, to which we look for direction on the path to attaining prosperity, harmony and equity in the 21st century.

Frene Ginwala
Speaker of the General Assembly in Parliament
15 August 1995, Cape Town

Message to the CSIR from the former Minister of Trade and Industry

Mr Trevor Manuel,
former Minister of the
Department of Trade and Industry

The Department of Trade and Industry, whose Minister has been assigned the responsibility of administering the Scientific Research Council Act No 46 of 1988, has had a long and productive association with the organisation.

The approach to scientific research has changed over time to adapt to the changing environment and to meet the needs of the community it serves. Accordingly, the CSIR has moved away from research for mere knowledge's sake to more goal-directed research aimed at promoting technology development. By 1987 the CSIR was transformed into a contract research organisation which is today 60% self-funding, using the Government's investment for capacity-building research and the maintenance of a major portion of the science and technology infrastructure of the country. In 1993 the CSIR began to adjust its research strategy to increase its focus on technology for development to meet the needs of the new South Africa, a process which is rapidly gaining momentum.

As the largest research, development and implementation organisation in Africa, the CSIR is not only a national asset, but a technology resource capable of providing selected services to the whole continent. In the context of the Reconstruction and Development Programme (RDP), the CSIR is an important element of the national science and technology infrastructure which supports the country's industrial development. Its func-

tion is to strengthen South African industry's ability to compete internationally, to accelerate the upliftment of communities by providing technological support for small, medium and micro-enterprises, and to provide quality support in technology decision-making.

Its future role is to focus on those technologies that are in line with the country's identified national priorities. In the short term South Africans look upon the CSIR to select appropriate technologies from abroad and to adapt them to local requirements. At the same time the CSIR should endeavour to develop unique skills applicable to the local environment with the long-term view of exporting the resulting products or services.

As the Minister of the Department of Trade and Industry, I would like to congratulate the CSIR on its achievements of the past fifty years and look forward to an even closer association in our combined effort to achieve economic growth and to build a winning nation.

His Excellency the Honourable Minister Mr Trevor Manuel
May 1995, Pretoria

(Mr Manuel has since become Minister of Finance and no longer holds the portfolio for Trade and Industry.)

Message to the CSIR from the Minister of Arts, Culture, Science and Technology

Dr Ben Ngubane,
Minister of the Department of
Arts, Culture, Science and Technology

The CSIR was formed at a time of great global transformation and change in the dying days of World War II following the Allied victory in Europe. The foresight of Prime Minister Jan Smuts and Sir Basil Schonland led to the creation of an institution which became responsible in the ensuing years for the creation of research capacity and scientific and technological human resources on behalf of the nation.

South Africa is once again undergoing a fundamental transformation. The need for people of vision to create a platform for science and technology to make their critical contribution to the reconstruction and development of South Africa remains as challenging as it was for those early pioneers who created the CSIR. The Reconstruction and Development Programme (RDP) has identified science and technology policy as a key component for the provision of a high-quality social and economic infrastructure, as well as undergirding the industrial competitiveness of the nation. Scientific advances must be translated more effectively into technological applications. Small and micro-businesses must be created to support an effective manufacturing sector. Rural development initiatives require sustainable, cost-effective provision of water, energy, food and security, among many other things. Technology must be mobilised to humanise and transform working conditions and employment. Information technology must be harnessed to make both the Government and private sector role play-

ers more effective in their particular domains. These outcomes necessitate the provision of human resources and a national capacity in the sciences and in key engineering and technological fields. The challenge is considerable.

In order to achieve these objectives, organisations that are flexible and responsive to the emerging and identified needs, while able to maintain sustainable research capacity and develop new initiatives, will distinguish themselves from those who see the future as merely an extension of the past. Science and technology need a higher profile in South Africa. The creation of the Ministry of Arts, Culture, Science and Technology has demonstrated the importance attached to the science and technology domain by the Government of National Unity. Many initiatives are now under way to include science and technology in the broad debate that is, with its wonderful richness, transforming our country. The CSIR will undoubtedly make valuable contributions in aligning science and technology to national objectives.

The CSIR has a track record of excellence and has in recent years demonstrated a unique ability to respond to changing circumstances and new needs. It has played a key role in the past, and will continue to do so in the future. I commend them for their contribution to the field of science and technology over the last half-century. I wish them every success in their future endeavours which will form part of the greater team effort in which we are engaged as a nation as we prepare for the 21st century.

His Excellency the Honourable Minister Dr Ben Ngubane
Minister of Arts, Culture, Science and Technology
June 1995, Cape Town

Key to Acronyms

ACDRI	*Advisory Committee for the Development of Research for Industry*
AEC	*Atomic Energy Corporation*
ANC	*African National Congress*
ASD	*Administrative Services Department*
CBE	*Commander (of the Order) of the British Empire*
CCTA	*Commission for Technical Co-operation in Africa*
CEO	*Chief Executive Officer*
CNES	*Centre Nationale d'Etudes Spatiales*
COMRO	*Chamber of Mines Research Organisation*
CSA	*Conseil Scientifique de l'Afrique (Scientific Council for Africa (South of the Sahara))*
Cosatu	*Congress of South African Trade Unions*
CSIRIS	*CSIR Information Services*
CSIRO	*Commonwealth Scientific and Industrial Research Organisation*
CSP	*Co-operative Scientific Programmes*
EHS	*Environment, Health and Safety*
FIRI	*Fishing Industry Research Institute*
FOYSA	*Four Outstanding Young South Africans*
FRD	*Foundation for Research Development*
GDP	*Gross Domestic Product*
ICSU	*International Council of Scientific Unions*

IDC	*Industrial Development Corporation*
IDRC	*International Development Research Centre*
ISO	*International Standards Organisation*
IT	*Information technology*
IUPAC	*International Union of Pure and Applied Chemistry*
LAN	*Local area network*
LEAF	*Leadership Education and Advancement Foundation*
Mintek	*National Science Council for Mineral Technology*
NAC	*National Accelerator Centre*
NASA	*National Aeronautical and Space Administration*
NCS	*National Calibration Service*
Nehawu	*National Education, Health and Allied Workers Union*
Nosa	*National Occupational Safety Association*
NPI	*National Productivity Institute*
NPRL	*National Physical Research Laboratory*
OBE	*Order of the British Empire*
ORG	*Operations Research Group*
PAS	*Personnel Administration Standards*
PEAS	*Production Engineering Advisory Services*
RAO	*Radio Astronomy Observatory*
RDI	*Research, Development and Implementation*
RDP	*Reconstruction and Development Programme*
ROI	*Return on investment*
RV	*Research Vessel*
SAAO	*South African Astronomical Observatory*
SABC	*South African Broadcasting Corporation*
SABS	*South African Bureau of Standards*
SAC	*Scientific Advisory Council*
Saidcor	*South African Inventions Development Corporation*
Sanco	*South African National Civics Organisation*
SBDC	*Small Business Development Corporation*
Seifsa	*Steel and Engineering Industries Federation of South Africa*
SMME	*Small, medium and micro-enterprises*
STI	*Science and Technology Forum*
SWOT	*Strengths, Weaknesses, Opportunities and Threats*
TQM	*Total Quality Management*
UCT	*University of Cape Town*
UNESCO	*United Nations Educational, Scienctific, and Cultural Organisation*
VIP	*Very important person*
UK	*United Kingdom*
USA	*United States of America*

Prologue

THE JOURNEY BEGINS

Some two million years ago, ancient man[1] had taken to modifying natural objects such as rocks, sticks or bones to assist him with his daily chores. Perhaps the accidental flaking of a stone tool increased its effectiveness for cutting, scraping, digging or whatever was required for survival, and the mind of *Homo habilis* was sufficiently developed to grasp the significance.

The intentional application of this insight may have been the first technological feat ever performed on earth, and, by all current indications, occurred in 'darkest' Africa.[2] Although a minute step, viewed from the distance of the year 2000, it probably represents the first in the series of 'giant leaps' marking man's efforts to conquer ignorance, disease and space. Initially, however, the development of the means 'man' used in this quest was slow, gradually picking up pace with the emergence of *Homo sapiens* some 120 000 years ago.

Step by step these early innovators succeeded in harnessing the forces of nature. In the process, society became ever more complex. Early innovators began specialising in activities, determined by their environment and particular skills, and consciously produced a surplus to trade for goods they lacked or items of luxury.

Although society still depends on the ingenuity of individuals, it proved to be more productive to pool its resources. During the 20th century or-

ganisations were created, such as the CSIR, whose primary purpose was and is the development of technology. As we approach a new millennium, the globalisation of business has put the spotlight on science and technology to provide the competitive edge in commerce and industry.

So successful has man become in combating his natural enemies that he has proliferated to the point of overload. He must now face the challenge of managing himself as the enemy. The natural replenishment of the earth's water supplies, for one, may soon not be able to meet the growing demand. To preserve the earth's resources and the environment for future generations will require ever more efficient technologies.

Fortunately, 'the human mentality is limitless in its potential for creating mechanisms for peaceful survival. Our inherited capacities for invention are so immense that we cannot even begin to imagine how society will be organised 300 years from now'.[3]

TECHNOLOGY AND CIVILISATION

Science and technology are inextricably linked to the evolution of civilisation. Every step that led man out of the cave can be attributed to some breakthrough or incremental discovery that unlocked the mysteries of nature and so helped to improve the quality of life for all mankind. The benefits extend beyond our physical and material wellbeing. Once the struggle for survival is contained, there is time for developing and enjoying the further dividends of civilisation: the ethics and aesthetics that lift man above the realm of the animal – art, music, religion, philosophy, formal education, organised commerce and constructive leisure.

It is an indictment against humanity that, on the threshold of the 21st century, we have not managed our technological assets better and that a vast number of the world's population are still fighting for survival or misapplying the products of technology to destroy each other or the very earth on which we live.

South Africa has turned a corner and is making a concerted effort to redress the political wrongs of the past. Among the foremost goals is the general improvement of living standards, while preserving the environment for future generations. To achieve these goals a sound technological infrastructure is crucial to support the economic growth required for job creation. The rapid progress of some Pacific Rim countries in recent times confirms the belief that the key difference between an industrialised and a developing nation is the status of its technology base.

Science and technology capability is one of the main factors spurring economic growth in developing countries ... science and technology capabili-

ty requires a supportive political environment, opportunities for education, and links between the public sector and industry.

Science has been behind the meteoric growth of Taiwan and the 'dragons' of Asia. Science was used first to generate the technologies needed to give industry a basic infrastructure. These technologies were then improved to create industrial growth.

The Asian successes came from an innovative implementation of science and technology, with policies based on factors such as international market demand and foreign technology rather than the blind promotion of indigenous science and technology capacity as automatically contributing to economic growth.

The model of Asian newly industrialised countries is significant because it highlights the importance of flexible government policies and confirms that science and technology are crucial to developing countries' futures.

UNESCO, *World Science Report*, February 1994.[4]

Until World War II the technological history of South Africa had been mostly confined to two areas, agriculture and mining. This is typical of emerging economies the world over. Economists and leading businessmen have long preached the gospel of adding value and moving away from exporting unprocessed raw materials. Having been blessed (or cursed) with abundant supplies of prized raw materials, there has been little pressure on South African entrepreneurs to forgo the lucrative but short-term earnings they provide in favour of investing the profits in developing secondary industries such as a sophisticated manufacturing industry, geared to exporting quality goods. Few major producers of mineral products worldwide have managed to escape the pattern.

The CSIR was created after World War II to undertake basic and applied research in order to boost the development of the country's primary and secondary industries – basic research to generate knowledge, and applied research to generate technology. Funded by a government elected by a white minority, research priorities were determined to serve minority interests and much of the benefit derived from the resulting technology for the majority was indirect or prompted by ad hoc infrastructural demands. An education policy insensitive to the technological needs of the future resulted in an inadequately prepared workforce to capitalise on the achievement of full democracy in South Africa.

By 1985 a series of events had induced the CSIR to assess its value to the country and redefine its role accordingly. The CSIR embarked on a revo-

lutionary change in direction, breaking away from research aimed at knowledge for the sake of knowledge to concentrate on goal-directed research to promote technology development. The findings of the International Development Research Centre (IDRC) study, published in 1993, highlighted other serious shortcomings in the make-up of the now market-oriented organisation[5]. The report severely criticised the neglect of the interests of the majority of South Africans by the country's foremost practitioner of technology. The CSIR embarked on further transformation to increase its ability to address the most pressing needs of the new South Africa. Within the framework of the RDP, its main thrusts are providing technology to underpin the country's ability to compete internationally, technology for development and technology for decision-making.

The CSIR celebrated its fiftieth anniversary in October 1995. To put the past fifty years in perspective, we take a brief look at the dawn of technology in Africa, its subsequent development, and the CSIR's role in this development. We touch briefly on the progress of man from a subsistence to a pastoral existence, the emergence of mining and the trade inspired by its products, informal individual scientific achievements, to the main focus of the story, namely how the CSIR came into being, what it was and why it decided to change. The emphasis is on the past fifteen years[6], with an in-depth look at the transformation processes, their effect on the organisation and its people, the learning experience associated with radical change, and the way the CSIR is fulfilling its role in the rapidly changing environment, both locally and internationally. The story is in fact that of an endless journey of learning and a 'passage to progress'.

Out of Africa 1

Ex Africa semper aliquid novi.
(Out of Africa always something new.)
Pliny, The Elder – *Natural History*

THE DAWN OF TECHNOLOGY

The history of man's progress in southern Africa is also the history of its technology. Archaeologists have traced the appearance of prehistoric tools back to the Early Stone Age, so named because its technology was dominated by the use of mainly stone implements.

Food and shelter are the most basic survival needs of man. From the earliest days, man was driven to improve his methods of hunting, food gathering and shelter construction. Natural objects were found and modified to form the implements he used to improve his chances for survival. Thus man developed methods for doing things to suit his purpose without necessarily understanding how they worked, for example, the control and exploitation of naturally occurring fire, caused by lightning or the spontaneous combustion of dry material. Evidence found at Swartkrans, west of Johannesburg, indicates the controlled use of fire by inhabitants as early as 1 million years ago.[1]

Not being able to explain such natural phenomena, technology in its earliest form was associated with the practice of magic, while science was intimately linked to myth and ritual. The ascendancy of reason led man to 'probe and to find out why, or alternatively to fabricate reasons and explanations – mythologies to satisfy his growing curiosity'.[2] The age-old quest for answers is the very foundation of science. The skill to exploit the acquired

knowledge to the benefit of the community is the realm of technology.

In his efforts to placate the gods, who seemed to thwart his struggle for survival, man was inspired to manufacture artefacts that further challenged his innovative and artistic abilities. As our knowledge increased about the workings of nature, the better equipped we became to ensure our survival. The quest for knowledge steadily eroded the grip of ignorance and its associated fears, at the same time increasing man's respect for the unfolding complexity of the universe.

The concept of Africa as the cradle of man took hold following Professor Raymond Dart's interpretation of the significance of the Taung skull found in 1924 and subsequent discoveries at Sterkfontein, Kromdraai, Makapansgat and Swartkrans. This assumption was supported further afield by the Leakey family's finds in the Rift Valley. The primitive stone tools produced by the early representatives of man were gradually improved until well-formed hand axes and cleavers became the norm in the Early Stone Age. The emergence of anatomically modern humans in Africa coincided with the development of a greatly improved technology for modifying stone to create the tool kit of the Middle Stone Age people.

Apart from producing the earliest known tools, some bone fragments from 100 000 years ago were discovered quite recently, decorated with simple incised patterns, which could turn out to be the earliest known examples of art on earth – again in southern Africa.[3]

Active mining of natural resources also emerged during the Stone Age. A widespread demand for coloured or glittering minerals gave rise to an intensive search for pigments, used either for ritual or cosmetic purposes. The ancient custom of burying red pigments with a body is found worldwide. The red colour is associated with blood, considered to be the essence of life and therefore containing the power to restore life, hints at a growing belief in an afterlife. Red haematite (Greek for 'blood stone') was widely used for this purpose.[4]

Surface exposures of the more desirable and localised varieties were soon exhausted and the collectors turned to underground sources, extracting the ore mainly by means of various hand-held stone tools, which were later supplemented by metal gads[5] during the Iron Age. Many examples of haematite and specularite mining have been found in southern Africa, thought to be almost certainly the world's first efforts at mining.[6] At Lion Peak in Swaziland, mining of red haematite dates back to more than 40 000 BC and persisted into the early years of the twentieth century[7]. This pigment mining tradition represents the formative phases in the worldwide history of mineral exploitation.

The Later Stone Age, starting roughly 40 000 years ago in southern

Africa, heralds the consistent appearance of practical assemblages; of art and items of personal adornment, such as rock paintings, engravings, beads, decorated shell pendants and amulets; of specialised hunting and fishing equipment such as bows and arrows, snares, traps, poison mixes, fish hooks and sinkers; a greater variety of scrapers for skin working, bone needles and awls; of specialised food-gathering tools consisting of a range of containers and digging sticks. The Stone Age herders, who introduced domestic livestock into South Africa some 2 000 years ago, also introduced the technology for producing well-fired pottery.[8]

THE IRON AGE – A QUANTUM LEAP

The Iron Age brought increased sophistication in ceramics production and design, iron-working and agriculture. Millet and sorghum were cultivated from around AD 300. During the 17th century, survivors of the Portuguese ship *Santo Alberto*, which sank off the south-east coast, reported the inhabitants as brewing 'wine' from millet, fermented in clay vessels 'which they drank with great enjoyment'.[9]

Iron smelting was widely practised, each settlement apparently producing its own requirements. Any surplus production was used for trading. Soapstone working, salt making and ivory carving, too, were among the country's early industries.

The hunter–gatherer culture still prevailed in localised areas, but had largely given way to a pastoral one, leading to the development of more permanent dwellings. Hut construction consisted mostly of burnt *daga* (adobe), or poles and reedmats, and thatch. Stone walling made its appearance, with that of the Great Zimbabwe as the prime example. These settlements revealed an increasing inequality of wealth in domestic stock, leading to the establishment of larger and more complex socio-economic units.[10]

The Great Zimbabwe was however preceded by Mapungubwe, south of the Limpopo, as the trading hub of southern Africa. Both belonged to the same cultural tradition. Evidence of the flourishing trade at Mapungubwe is the presence of large numbers of glass beads and shards of Chinese pottery. Spindle whorls too were found there implying that cloth manufacturing could have taken place. The key to this concentration of activity was gold. Initially techniques used earlier in iron and copper working were transferred to gold, but later large items introduced sheet goldwork attached to a carved wooden core with gold tacks. By the 13th century, gold had become a major export item along with ivory and to a lesser extent leopard skins and tortoise shell.[11]

The Great Zimbabwe settlement, dated to the 13th and 14th century[12],

took over from Mapungubwe as the main trading centre. With its extensive stone walling and hill-top and valley components, the Great Zimbabwe introduced the first urban concept in southern Africa. The elite sections and enclosures, some linked with covered passages, had controlled access, clearly showing class distinction in society. It had an estimated population of some 11 000 inhabitants.[13]

From the middle of the 15th century a degree of specialisation into subsistence farming and metal production took place, largely determined by the environment. Areas of concentrated metal production occurred in parts of the well-wooded lowlands of the present KwaZulu/Natal and the northern provinces of South Africa such as at Hluhluwe and Phalaborwa.

Furnaces were generally of the low shaft kind, ranging from sub-triangular to circular and oblong with openings for the air inlets. Iron and steel were used mainly for implements especially hoes, spearheads, leaf-shaped knife blades, axes, adzes, mining gads, razors, awls for sewing as well as ornaments such as beads and bangles. The production of copper and tin was more localised, the items crafted being essentially decorative. Techniques included chain making[14], casting, wire pulling and sheet-working.[15]

Mining and metallurgy are the elemental industries that form the foundation upon which mankind began to transfigure the earth.[16] The mining tradition in southern Africa spans many centuries. The earliest known furnace sites in South Africa are found near Tzaneen and have been dated to about AD 270.[17] The ancient miners performed miracles with the simple tools and techniques at their disposal, tools they must have generally fashioned for themselves. Their skill in prospecting speaks for itself – they had missed only one occurrence of gold in Zimbabwe.[18]

RJ Mason sums up the importance of the Iron Age in the southern African region:

> *The phrase 'Iron Age' in the South African context refers to technology that led to the earliest major transformation of human society in South Africa. Iron Age technology was based on farming and metal production, which led to fundamental changes in the South African economy, South African politics, and South African social relationships. Before the Iron Age, everything was on a small scale in South Africa so far as human beings are concerned. After the Iron Age, the way was open for the emergence of our present large-scale South African society ... South Africa today could not have been built without the foundation of human aptitudes for complex industrial labour created by the Iron Age.*[19]

MAKING OF THE RAINBOW NATION

About a thousand years ago there was an influx of the ancestors of the present African-language speaking people through what are now known as Zambia, Zimbabwe and Mozambique into the northern provinces of South Africa, the Free State, KwaZulu/Natal and the Eastern Cape. Although few in number, their superior technological, social and political systems led to rapid integration and a remarkable dispersal of lineages and languages. By the 14th to 15th centuries the main settlement areas, as known historically, were established. Only the drier areas of the interior and the southernmost and south-western regions remained populated by Khoisan hunters and herders.[20] Techniques for improving hunting methods and finding and storing water in the semi-desert areas proved a healthy stimulus for the innovative ability of these peoples.

Towards the end of the 15th century the Portuguese had rounded the Cape, opening up this sea route for Europe to the East. Another 150 years went by before actual colonisation of the southern tip of Africa began. The Dutch established a settlement in the Cape in 1652 to help supplement their food and fresh water supplies on their trading trips to the East. They extended their labour force with slaves and labourers mainly from India and East Asia, Madagascar and the East African mainland.[21] The settlement was further strengthened by the French Huguenot contingent (from 1688 onwards) and later by British and German settlers (during the 19th century), each group bringing with them their particular skills and contributing to the technological development of the country.

The early colonists' extensive exploration of the country led to trade and eventually strife with the indigenous peoples in the east. Britain finally took over government of the Cape from the Dutch in 1806 and gradually annexed more and more territory for the British. During the 19th century some Afrikaner frontier farmers, the Voortrekkers, left the British Cape Colony to establish their independence. They founded the Republic of Natalia, which lasted for four years, followed by the Republics of the Free State and the Transvaal.[22] Their aim was initially to farm the land, but in the process they got caught up in a struggle for control of the lucrative gold and diamond mines, a battle won by the British in 1902.

During the latter half of the 19th century Indian labourers were imported to work the sugar plantations in Natal. The gold rush at the turn of the century brought entrepreneurs and adventurers from all over the globe. In 1910 the Union of South Africa was formed, with agriculture and mining forming the basis of the new economy.

The subsequent expansion of the economy prompted the importation of additional labour forces. The mines contracted workers from China,

Mozambique and Malawi, many of whom stayed on. The country was also an attractive refuge for some Portuguese and Belgian colonials from Mozambique and the previous Belgian Congo. During the 1960s South Africa's technological workforce was strengthened by imports from both Western and Eastern Europe, and the country is currently experiencing an influx from neighbouring African states to complete the present 'rainbow nation' of South Africa.

THE QUEST FOR GOLD

Mining, particularly of gold, played a key role in the development of southern Africa, both culturally and economically. Phoenician traders allegedly circumnavigated the African continent at the beginning of the 6th century BC. One of their main aims was to find gold. By the 12th century BC gold was being used fairly generally as currency between Egypt and India. Evidence of hard rock mining of gold-bearing quartz veins has been found in Egypt dating back as far as 1360 BC.[23]

Of the European nations the Greeks were the first to join the universal gold rush in Africa, first by looting and then by mining in Egypt. By 50 BC gold mining in Egypt had become highly organised, some mines being worked horizontally while others went down to a depth of 20 metres.[24]

Arabian ships had sailed as far south as Madagascar, the Comores and the Zambesi before the Christian era. By the 10th century AD the Arabs had reached Sofala, near modern-day Beira. They started exporting iron from Sofala to India and China, and by the 12th century the trade included gold. Intensive trading during this period of Arab exploration took place with the widespread ancient mining communities north and south of the Limpopo.[25]

The Crusaders (1096 to 1291 AD) heard tales in their travels of the wonders and glories of Africa. Later Arabian writers and travellers told of the rich gold deposits of the continent. In the revitalising throes of the Renaissance, Europe hastened to explore the African continent, which eventually led to its systematic colonisation for almost four centuries.[26]

During the 14th and 15th centuries the gold for the currencies of Portugal, Spain and Italy came exclusively from West Africa. After the Portuguese reached the east coast of the continent in the early years of the 16th century, they began a search for the legendary Monomotapa and the country of Prester John, but by this time gold production in the inland had apparently slowed down significantly and very little gold was found.[27]

The 19th-century prospectors came upon ample evidence of metal ore mining and smelting in the north-eastern part of southern Africa. Alluvial gold was possibly collected in the Pilgrim's Rest area, while the many

shafts found in central Zimbabwe indicate that several tons of gold-bearing rock had been removed.[28]

Copper workings were discovered as far afield as Katanga and Zambia, round the fringe of the gold district in Zimbabwe, at Messina, Phalaborwa, Wagondrift at the foot of the Drakensberg and at Rededzi on the border of the Kalahari. Ancient tin mines occurred on either side of the Limpopo, at Rooiberg, Leeuwpoort and in the Waterberg district. Some of these old workings extend to a depth of almost 70 metres and would have produced several thousands of tons of copper and tin.[29]

Metal gads were used as chisels and crowbars to prise the rock face apart; the technique of fire setting with subsequent water cooling was also used. Grading of ore was often done underground, the tailings being used to support the tunnels. The BaLemba people had apparently mastered the technology for the casting of copper rods and the drawing of copper wire.[30]

Sir John Barrow wrote of his travels in 1801 and 1802 stating that he had found gold ore beyond the Orange River, and drew a map featuring what could have been either the Witwatersrand or Magaliesberg mountains that were reputed to contain gold which was already being extracted. This was the first recorded reference to gold in the Transvaal in colonial times.[31]

Several travellers in the first half of the 19th century reported that black inhabitants north of the Vaal were mining and working gold and a great quantity of iron. These reports were confirmed by the notes in Voortrekker Louis Trichardt's diary.[32]

A steady flow of promising finds of gold-bearing ore kept prospecting in the Witwatersrand area alive until it was well established by the end of the 1880s. At first mining methods were very simple. A few shafts were sunk, but in general mining consisted merely of trenching the outcrops to depths of about 20 metres. As more and more shafts were sunk, they became progressively deeper and were connected underground at varying depths, the gold yield becoming ever more promising.[33]

The infrastructure demanded by the fast-growing mining industry stimulated the technological development of the region. An adequate water and coal supply, a transport system and constant food supplies had to be ensured. Methods of extracting the metal had to be refined and developed to make them profitable. In the years to come South Africa would become a world leader in mining technology as special techniques were devised to develop what would become the world's deepest mines.

THE QUEST FOR KNOWLEDGE

During the colonial era before 1910, scientific research in South Africa was-

dependent on the sporadic efforts of enthusiastic individuals, mainly associated with museums and universities. The country's particularly rich fauna and flora stirred international interest and attracted distinguished scientists to collect specimens for study – mostly in Europe. The names of natural scientists such as Thunberg, Masson, Gordon, Burchell and Paterson have been immortalised by the numerous species named after them.

But it was the African sky that attracted the first scientist of note to spend some time in South Africa. Abbé Nicolas Louis de la Caille was sent by the French Academy of Sciences in 1751 to determine the positions of the brighter stars. The Abbé did not limit his scientific pursuits to the dark hours only, but filled his days by doing land surveys for the Government and calculated the exact longitude and latitude of the Cape for good measure.[34]

Following the progression of talented naturalists who confined themselves to observing and recording data about the local fauna and flora, a few outstanding amateur scientists did pioneering work on their own for the sheer pleasure of pursuing knowledge. Andrew Bain who was contracted to build military roads. With a keen interest in geology, he capitalised on the opportunity, and discovered the first reptile fossils in the Beaufort Series and drew up the first geological map of South Africa. Eugene Marais, a qualified lawyer, did astounding research on baboons and termites, formulating theories in the process that demand respect and attention to this day.

There were also trained scientists such as Hans Merensky whose thorough knowledge of geology led him to make accurate predictions about South Africa's immense mineral deposits; Jan Smuts whose philosophical treatise on the theory of holism still provides insights that find application in a variety of disciplines today; and archaeologists Van-Riet Lowe, Broom and Dart whose findings revolutionised the theories of the origin of man.

The need to pool scientific resources led to the establishment of research societies and government-sponsored institutions.[35] The colonial period preceding World War II was dominated by government initiatives to bolster its mining and agriculture-based economy. A brief look at these largely reactive initiatives traces the laborious path which led to the eventual establishment of the CSIR.

The first permanent scientific institution established in South Africa, again associated with the sky, was the Royal Observatory in Cape Town in 1820, set up to assist with marine navigation. It also provided a time service and helped launch a geodetic survey of southern Africa, which laid the foundation for its future mineral exploitation.

The development of scientific research in South Africa followed a pattern of starting with ad hoc research in a particular discipline to overcome

problems of immediate practical importance, leading to the establishment of a research institution. For example, the Veterinary Research Institute at Onderstepoort owes its existence to the outbreak of rinderpest in the Transvaal in 1896. President Paul Kruger invited Dr Arnold Theiler to investigate the problem. As a result of his excellent research on the subject, the renowned institute at Onderstepoort was inaugurated in 1908.[36]

After the Union of South Africa was proclaimed in 1910, the Government played an increasingly active role in developing formal research and providing scientific and technical services. From the outset the approach was an almost unqualified application of the British system as practised in other parts of the Commonwealth.

A meteorological office, a hydrological survey aimed at developing dams and irrigation schemes, a trigonometrical survey and a magnetic observatory were all established by the Government. The country's mineral riches inspired the early establishment of the Geological Survey of the Union of South Africa in 1912, followed by a Government Minerals Laboratory; and the hazards of mining spawned the Silicosis Medical Bureau. In the same year the South African Institute for Medical Research was founded by the mining industry with some government support. Service to the community depended mostly on voluntary financial contributions, while state support was sporadic and insufficient.

Research centres associated with agriculture increased steadily. By 1945 the Department of Agriculture could rely on nine centres for assistance. Among them the by-now famous Veterinary Research Institute at Onderstepoort, research institutes of the faculties of agriculture at the Universities of Natal, Pretoria and Stellenbosch, and the Citrus and Sub-Tropical Fruit Research Station at Nelspruit. An afforestation programme paved the way for the Forest Products Research Institute which eventually assisted public and private concerns throughout Africa.

Under the Department of Commerce and Industry two further scientific bodies were established, a Fuel Research Institute (1930), 50% funded by industry, and a Division of Sea Fisheries (1932), the latter to supplement the University of Cape Town's marine biological survey with the aim of regulating the exploitation of marine resources. The Sugar Experiment Station (1925) at Mount Edgecombe and the Leather Industries Research Institute (1941) are further examples of organised industrial research taking root.

These pockets of industrial research, whether instigated by the government or private enterprise, were largely aimed at the production and processing of raw materials. This is typical of a primary producer economy. The fledgling manufacturing industry produced a limited range of

goods for the local consumer market under licence to foreign companies – the classic colonial approach.

World War I showed up the vulnerability of countries dependent on primary products and lacking in significant secondary industries. The severe demands imposed on the manufacturing industries by the war prompted international awareness of the importance of science and technology. The governments of the USA, Britain and Germany began actively supporting industrial research. Britain devised a model for a research council system, which survives to this day, although in a modified form.

In an effort to co-ordinate industrial and university research in South Africa, the government appointed an Advisory Board for Industry and Science in 1916. Its head, Dr HJ van der Bijl, was convinced that a central research institute, financed by government, examples of which had already been established in other British Commonwealth countries such as Canada, Australia, New Zealand and India, was essential.[37]

Van der Bijl argued that successful industrial research required large-scale specialised facilities, manned by expert staff. Access to a national research organisation would benefit major companies with limited research facilities and even the smallest company with none. In this way methods and processes of manufacture could be improved to help combat competition in world markets. This was in 1921!

With the 1924 election looming, the Smuts Government put Van der Bijl's proposal on hold. Smuts lost to Hertzog whose administration relegated these recommendations to a lower priority. Among the Van der Bijl initiatives that did endure were the establishment of the Electricity Supply Commission (today's Eskom), the Iron and Steel Corporation (Iscor) and the Industrial Development Corporation (IDC), all of them still in existence.

The only survivor of the early government initiatives to support science and technology was the Research Grant Board that sponsored university research. This body was reorganised in 1938 into a National Research Council and a National Research Board. The council strongly supported Van der Bijl's recommendation for a national research institute made nearly two decades before. This very promising development was again frustrated, this time by the outbreak of World War II.

Once again the war emphasised the importance of secondary industries and the need for organised research in support of technological development. Under Van der Bijl's guidance as Director-General of War Supplies, South Africa became an important workshop serving the Middle East war arena. Millions of spare parts were manufactured, aircraft and ships were repaired, guns, bombs, armoured cars, precision instruments, military explosives and ammunition were produced, not to mention the clothing,

blankets, boots and canned foods provided for the Allied forces.

Abroad, the spectacular success of teams of scientists from various disciplines in solving problems under the pressure of war, with the associated civilian spin-offs that followed, put a new perspective on the contribution of science. Radar, synthetic fibres, pyrex, antibiotics, pesticides and of course the production of nuclear energy were all products that significantly affected our daily lives. It became evident that the scientists' ability to generate and implement knowledge held enormous advantages for mankind.

However, this success highlighted not only science's economic importance, but also its value as a strategic weapon. The funding of science received a tremendous boost especially in the military field. These boom years for science and technology lasted well into the 1980s.

After the war South Africa experienced a minor industrial revolution. The change from an agricultural and mining economy to a more diversified industrial one, triggered by the war years, created a variety of technological problems. The era of 'big science' had arrived and the gap between South Africa and the industrialised countries was rapidly widening. The need for a centralised body to co-ordinate local industrial research was no longer negotiable, but was a matter of economic and strategic necessity.

The Grand Design 2

If you can look into the seeds of time
And say which grain will grow and which will not ...

Shakespeare – *Macbeth*

AT THE DRAWING BOARD

With the outbreak of World War II the coalition government of Hertzog and Smuts split over the question of South Africa's neutrality or participation. Smuts assumed power in September 1939 and became an active member of the British wartime Cabinet. His contribution to the Allied war effort made him a much respected member of the new international order. The experience reinforced his belief in the necessity of a properly co-ordinated technological infrastructure to serve as a springboard for the national economy. He was particularly keen that South Africa should process its valuable metals rather than export unprocessed raw materials. He also did not want to face another war without the support of a national research facility.

As early as 1942 he had the vision to start planning ahead for such a facility. Based in London at the time, he held lengthy discussions with fellow South African, Dr Basil Schonland (later Sir Basil), on the subject.[1] So intent was Smuts to launch this initiative that he ignored army protocol. Schonland, who was tasked with establishing a radar activity at the outbreak of the war, held the rank of brigadier. Despite his own rank as field marshal, Smuts haunted Schonland's office at the Army's Operations Research Group (ORG) headquarters to discuss his vision of setting up a scientific research body to support industry.

Also at ORG were members of the colonial research councils, who gave the benefit of their experience. After many deliberations Smuts and Schonland reached an agreement on the basic framework for the proposed national facility. Smuts had been in favour of allocating research facilities to a university to fulfil the function, and favoured Cape Town. Schonland was adamant that such a facility should be centralised and available to all South African universities. The high concentration of mining and industrial activities in the Transvaal won the day. They both agreed that a high degree of interaction between the research facility and universities was essential for building up a national research workforce. Postgraduates would have access to specialised equipment to use for achieving their higher qualifications and bursars would have the benefit of experiencing an active research environment.

Smuts recalled Schonland from active service in 1944, shortly after VE Day, to serve as scientific adviser to the Prime Minister. Schonland was acutely aware of the poor support that research was receiving at that time. The only means of obtaining money for research was through the Research Grant Board, which was perceived to be notoriously mean. He saw the opportunity as a challenge to give his fellow scientists the service they needed and to provide encouragement to young scientists.[2]

Schonland's task was to formulate 'plans for the establishment of an organisation to advise the Government on the best methods of developing the country's natural resources to the full, and to co-ordinate scientific research in the national interest'.[3] He conducted high-level consultations with government departments, universities, organised industry, scientific and technical societies, and leading international scientists. Armed with these insights, he drafted a bill for submission to Parliament to establish the Council for Scientific and Industrial Research, modelled on Australian and Canadian examples.

During the second reading of the Bill, Acting Prime Minister Hofmeyr argued: 'A nation which 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'.[4]

Hofmeyr summed up the functions of the CSIR as follows: '. . . it will itself undertake certain types of research work, it will assist research work sponsored by others, it will foster the establishment of industrial research institutes, it will encourage the training of research workers, it will act in liaison with research activities in other countries and it will provide for the collection and dissemination of information in regard to research'.[5]

The bill was passed in June 1945, giving the national research body corporate powers outside the public service with no limits imposed on the fields

it should serve, but making it responsible to Parliament, through the Prime Minister, for its programmes and estimates, and subject to having its accounts audited by the Controller and Auditor General.

The first Council, consisting of 10 members, was made up of representatives with a strong industrial and scientific bias as determined by the Act.[6] Schonland was appointed the first President, Chairman and Chief Executive Officer of the Council. Smuts knew Schonland well and entrusted him with these centralised powers in the belief that it would help to speed up the establishment of the research facility.

The CSIR was legally constituted on 5 October 1945. The vacated premises of the Munitions Section of the SA Mint in Visagie Street, Pretoria, was rented from the Public Works Department to serve as interim accommodation while a suitable site for a permanent home was being sought.

The CSIR's relationship with government departments, semi-government bodies, universities and museums was defined at a meeting, called by Smuts, of the relevant department heads to ensure the efficient co-ordination of research in South Africa and to entrench its role in supporting industry.

At its first formal meeting (8 October 1945), the Council decided on a basic policy guideline for the CSIR, which outlined its plans for encouraging research by individual firms through remission of income tax; developing co-operative industrial research institutes supported by associations of firms; establishing national scientific laboratories to undertake long-term research and short-term ad hoc investigations on behalf of industrial firms under contract; fostering research in universities through grants and bursaries, and in co-operation with universities, creating conditions through which the best science students could be offered a reasonable livelihood in scientific research; establishing a central library and technical information service as well as scientific missions in London, Washington and other centres to provide a well-organised flow of information from the best sources in the world.[7]

The Council felt strongly that industries should be encouraged to accept responsibility for the funding of technological research. This initiative met with limited success.

The CSIR, on the other hand, was to concentrate on that research which would inevitably be neglected by industry. The National Physical Laboratory, National Chemical Research Laboratory and National Building Research Institute were the first of the national research institutions to be established.

The overall objective during the first 40 years of the CSIR was building scientific capacity for the nation, with the emphasis on developing the associated human resources, and creating the university research capacity

that was lacking in the period following World War II. In practice these aims were pursued mainly with respect to the white minority. During the first twenty years, the CSIR evolved a research infrastructure and a reputation for research excellence, while maintaining close contact with industry. Many industrial problems were solved and, where required, aspects were referred for fundamental research to obtain a solution. During the next two decades the emphasis gradually shifted to own-choice research and research prompted by political considerations. This approach to science and technology marked the character of the CSIR until 1985.

Only then, after some eight years of critical introspection and realising that much of the organisation was no longer in tune with its environment, did the CSIR return to a long-neglected statement made at its first formal meeting, in fact the very first sentence of the outline of the objects and policy of the CSIR: 'This is the century of applied science, of the application of the results of laboratory research to every activity of mankind'.[8]

THE MAIDEN VOYAGE

As very little active research was being done in the country during the mid-1940s, even at universities, the Council had difficulty in recruiting trained research workers.[9] Preliminary recruitment of suitable staff had already started in London among the South Africans engaged in the war effort, Dr Frank Hewitt being one of the first to be drafted. Key scientists were sought out locally to do the pioneering work. Dr Denys Kingwill, who served in the meteorological section of the South African Air Force during the war, became professional assistant to Schonland in 1945 to help him establish the national research centre.

Schonland sought out fellow physicist, Professor Stefan Meiring Naudé, head of the Physics Department at the University of Stellenbosch, to lead the National Physical Laboratory at the CSIR. When Schonland offered Naudé the job, he was reluctant to leave the university where he was intent on pioneering a spectrometry activity. Schonland is reported to have jokingly threatened him that if he did not take the job, he would appoint an Englishman instead. Naudé needed no further persuasion.[10]

Several of these recruits were sent overseas to acquire first-hand experience in selected research areas and returned to apply and adapt their knowledge to suit local conditions. Among them were Ernst Dohse who helped set up the building research activity, later to be headed by Jere Jennings, and Dr Eric Halliday who started the measuring standards activity. The chemical research laboratory began operating in 1948 after the appointment of Dr William Rapson, professor-designate in organic chemistry at the University of Cape Town. The wartime experience of Smuts and Schon-

land led them to ensure that worldwide scientific developments were monitored and that the CSIR kept up to date with military requirements. Schonland had a core of four or five scientists who did just this – the foundation for strategic research had been laid.

After five years, when Schonland resigned, two more national research institutes had been added to the original three, namely Telecommunications under Dr Frank Hewitt and Personnel Research under Dr Simon Biesheuvel. Four industrial research institutes had also been established. They were the Leather Industries, the Fishing Industry, the Paint Industries and the Sugar Milling Research Institutes.

These four industrial institutes were set up around existing activities under the auspices of the CSIR and the industrial research association scheme, a concept strongly supported by the Federated Chamber of Industries which believed that industry should accept responsibility for research. Being associated with the CSIR put the institutes' laudable but sometimes struggling research efforts on a much firmer footing, both scientifically and financially. All four institutes were set up in association with a university.

These industrial research institutes were financed by annual subscriptions, guaranteed by the majority of firms in the industries concerned, matched by an approximately equal grant from the CSIR. They were registered under the Companies Act as non-profit companies managed by boards of control on which the industrial contributors had majority representation. The research programmes were confined mainly to directed research problems of common interest to member firms and to the solution of technological problems which arose in the operations of individual factories. By the very nature of their training, scientists are expected to be objective and analytical, characteristics that probably explain why the CSIR, contrary to common practice at the time, exercised less discriminatory practices as far as women were concerned. As a government-established organisation, the CSIR was constrained by the policies and laws of the government of the day and few black scientists or engineers found their way into the organisation. The CSIR did however manage to establish contact with the science community in the rest of Africa.

The addition of an industrial psychology research group introduced some involvement with the broader population. Before being incorporated into the CSIR, the group had operated as the Aptitude Test Section of the South African Air Force, branching out into developing selection tests for all categories of staff. So successful was this group under Dr Simon Biesheuvel that Schonland decided the CSIR should involve itself in research in industrial psychology. The group was incorporated into the CSIR as the Bureau for Personnel Research.

One of its most spectacular successes was the pioneering of specialised aptitude tests for the mining industry to identify leadership potential among mine workers and in developing this talent to the full. These tests broke new ground as many of the candidates were illiterate and came from diverse cultural backgrounds. As a result of the Bureau's success, it became a fully fledged national institute of the CSIR in 1948. This involvement with developing the labour force gave the CSIR a wider perspective of its role in contributing to the country's development, and in this respect it was well ahead of its peers.

The first years were characterised by development and education. The progress made was impressive. Apart from setting up the basic facilities for the physics and chemistry laboratories, including the founding of the national measuring standards activity, applied research was well and truly launched. By 1950 a total of 158 applied research projects and investigations had been undertaken for industrial and other sponsors.

There were research programmes on the chemistry of available raw materials for industrial use such as plant and animal products, coal tar and bituminous materials, on water treatment, and on low-cost and high-density housing, to name but a few.

Two other technological statutory bodies came into being during this period – the South African Bureau of Standards (SABS) in the same year as the CSIR and the Atomic Energy Control Board in 1948. The CSIR was responsible for maintaining and developing the fundamental standards of physical quantities or units involving basic research work, while the SABS was primarily concerned with quality acceptance standards for manufactured products and the associated testing services. Government did have second thoughts on the matter and for a period of six years from 1956 to 1962 the SABS amalgamated with the CSIR, only to be separated again after bitter infighting.

The CSIR suffered a loss in status when the government changed hands in 1948. It no longer reported to the highest government office, namely that of the Prime Minister, but to the Minister of Economic Affairs, with no mention of science or technology in the ministry's name. From that time onward, the CSIR has had to conduct a continuous campaign to bring the importance of science and technology in the national economy to the attention of Parliament.

This was however not the only setback the CSIR suffered as a result of the change in government. As the government of the day practically owned the CSIR, it gradually started treating the organisation not only as a national asset to serve the country's needs, but to influence research di-

rection and priorities to serve its political ends. Some political appointments followed, many of them in leadership positions, and the incumbents in turn tended to employ staff of the same political persuasion. Although the best man did not necessarily get the job, scientific merit remained a precondition. At the scientific level on which the CSIR was operating, professional credentials had to be, if not impeccable, at least of the highest order.

In an effort to promote scientific and technical co-operation in Africa, the CSIR and the Department of Foreign Affairs arranged an African Scientific and Regional Conference in Johannesburg in October 1949. As a result of its success the Scientific Council for Africa South of the Sahara (CSA) came into being and for many years provided a framework for co-operation on technological problems specific to Africa and for developing the human and material resources of the continent.

Dr PJ du Toit, deputy president of the CSIR and former director of the Veterinary Research Institute at Onderstepoort, was elected Chairman of this Council, a position he held until 1960. Council members met annually and their primary allegiance was to the advancement of science for the benefit of sub-Saharan Africa.

The metropolitan governments of the colonial powers established an independent body following the conference in 1949, the Commission for Technical Co-operation in Africa, their concern centring mainly on financial and administrative functions. These two bodies joined forces after a few years to facilitate co-operation, the Commission being the executive authority and the Council its scientific advisory body.

This logical union proved to be unfortunate for scientific co-operation in Africa. The Commission, as an intergovernmental body, carried the stigma of colonialism, and the newly independent African states consequently rejected the organisation as a whole. Yet at the time the Council was dismantled in 1965, much had been achieved in the fields of agriculture, nutrition, health, roads, forestry, education and housing.

Schonland had initially undertaken the presidency of the CSIR for three years, but stayed on until 1950. He was succeeded by Dr PJ du Toit, who had joined the CSIR Executive as Deputy President in 1948 after his retirement as director of Onderstepoort, a position he held from 1927. One of the most brilliant men ever employed by the CSIR, he presided for two more years. During this time industrial research increased with the formation of the SA Wool Textile Research Institute and the Bituminous Binder Research Unit.

FULL STEAM AHEAD

The third President of the CSIR, Dr Stefan Meiring Naudé, had been ear-

marked for the presidency by Schonland right from the start, and was being groomed for the job in the two years he served as vice-president under Du Toit. He was a prominent physicist who had rubbed shoulders at the University of Berlin with Nobel Prize winners such as Einstein, Von Laue, Planck and Nernst.

Based on his own successful career, in true Western tradition, Naudé upheld the CSIR's policy of appointing the best graduates from South African universities. A select squad was sent to study at prestigious institutions overseas and formed the nucleus of the CSIR's research force. This policy was vindicated in later years by the outstanding contributions of its scientists to the development of science in general in South Africa and in raising its status to international levels. One such initiative was the setting up of primary measuring standards in South Africa rather than secondary standards, which gave industry the advantage of calibrations that are traceable locally to the international level of accuracy, thus elevating the sophistication of the manufacturing industry.

Contact with overseas scientific organisations invariably serves to broaden the perspectives of staff and has a significant influence on the direction of research and research management. Such contact impressed on the geographically remote South African scientists that science was an international commodity. They also realised that no matter how good the CSIR was, it still offered only limited experience to professional scientists. However, the CSIR had achieved international standing and being associated with it was an enormous advantage, because it gained scientists acceptance. For quality information, they needed to have something to offer in return.

Schonland was strongly influenced by the example of the British National Physical Laboratory at Teddington. The Western approach at the time was that a beautiful garden setting, as found at Teddington, would create the right atmosphere for researchers to do their creative best. This vision became a reality when Naudé secured from the University of Pretoria a natural park-like site to the east of the city for the CSIR's permanent home. With its sprinkling of indigenous animals and abundant bird life, it has become both a drawcard for employees who cherish the pleasant atmosphere and a source of great admiration from visitors, especially from abroad, who often request photographs to show at home.

The unprecedented expansion of research and development following World War II – the beginning of the so-called 'big science' era – favoured the development of the big powers. It was the birth of the space age which, because of the vital importance of 'fail-safe' communications and data control, also accelerated the development of information technology. The latter is seen as a watershed, similar to that sparked off by the invention of

the wheel, the steam engine and printing.

The CSIR was faced with the challenge of dual obligations. The first was to boost South Africa's rapidly developing industry by operating at the cutting edge of scientific research and high technology and creating selected centres of excellence. The second was its obligation to support the development of the rural areas with applied research. This was a challenge many other countries were grappling with, also with limited success. Not only is basic research essential for the country to remain competitive but it often has a better chance than applied research of providing technical spin-offs and solutions to quite basic community problems. Neither can therefore be neglected at the expense of the other.

In response to this complex situation, Naudé encouraged those new directions of research for which there was financial support from industry or other sectors, while always insisting on scientific excellence. The credo was that research should be led and not managed. This virtually anti-management approach was still in line with the world trend and government's original brief to establish a basic research and development capability related to the country's industrial needs.

Competition for research funds prompted the Government Treasury in 1957 to place a 7% limit on the annual growth of the CSIR's budget. This did not stop the CSIR from expanding, the potential shortfall being compensated for by its income from contracts. This development brought it into competition with other research agencies, which compromised its national advisory and co-ordinating role. The result was the creation of the Scientific Advisory Council (SAC) in 1962 to provide a neutral forum for discussing research and development policy issues nationwide.

During the two decades of Naudé's presidency, the CSIR's staff increased from 685 to over 4 000 and the number of national institutes from five to 13. The new institutes were mostly in the applied fields such as nutrition, water treatment, road construction, mechanical and electrical engineering and defence research. The CSIR's budget grew to a total of R2,6 million by its tenth year, to R15,6 million by its twentieth year and to R22,6 million at the time of its 25th anniversary. Income derived from contracts increased from 4,3% of the total in 1951 to 37,4% in 1971.

In view of its limited financial resources, the CSIR introduced a scheme in 1958 in support of the industrial research institutes. The idea was to establish such research units in future within the framework of existing national research institutes as opposed to setting up costly separate institutes. Among them at varying intervals over the next three decades were the Air Pollution, Timber, Sorghum Beer and Microbiology research units.

The government unfortunately, to an increasing extent, imposed limits

on the CSIR's discretion to determine appropriate salary scales for its staff. Bureaucrats with little understanding of a scientific organisation enforced the same rules and regulations on the CSIR as they were applying in the public service. The result was a gradual entrenchment of what is popularly perceived as a civil service mentality in a large portion of the workforce, more particularly among the administrative staff. However, a core of dedicated researchers carried on with their good work for the sheer joy of doing what they loved best. They were responsible for the CSIR's good scientific reputation, and from this core would eventually emerge the force that would take the destiny of the CSIR into its hands.

But many good scientists left, some of them emigrating to greener pastures overseas, which weakened the technological fabric of both the organisation and the country. The ludicrous situation arose that key researchers could not be paid what they were worth as the prescribed remuneration system only provided for small incremental improvements to their salaries. When such a wronged specialist eventually resigned, the system allowed his replacement to be paid a competitive salary, but only if he was from outside the CSIR. Such specialised experts often had to be recruited overseas, incurring still further costs by having to carry the relocation expenses of both the scientist and his family.

By 1969 one of the CSIR's respected Deputy Presidents, Dr Niko Stutterheim, resigned 'in protest against the encroachment of civil service bureaucracy on this essentially research-oriented organisation where independence of thought and freedom of action are paramount considerations'.[11] By implication this statement could be interpreted to include both administrative and political bureaucracy. His vision of attaining more autonomy for the CSIR was shattered after repeated attempts to present the case fell on deaf ears. The introduction of framework autonomy some twenty years later vindicated Stutterheim's efforts to some extent. To make matters worse, although he had good reason to expect to follow Naudé as President, his supporters suspected that he had little chance of success because of his political orientation, or lack of it. However, the irresistible force of the eventual successor's personality was respectable competition indeed.

TURBULENT WATERS

The next ten years (1971–80) under Dr Chris van der Merwe Brink, successor to Dr Naudé, coincided with a period of increasing international disillusionment with science and technology.[12] Progress in this area was increasingly being equated with the destruction of the environment, a side effect that should have been attributed to the inadequate management of

technology. Intense environmental lobbying exploited the energy crisis to intensify the anti-nuclear protest. Technology had not solved the problems of the developing countries fast enough, which eroded confidence in its potential contribution still further. Clearly, the time had arrived to make the benefits of science and technology more relevant and visible. Researchers returning from abroad brought back news of growing disillusionment with unfettered research and the increased emphasis on relevance and industrial research.

While the negative image of science and technology also affected South Africa, circumstances created a certain demand for local technology. In the era that followed the Rivonia trial in 1962, ever harsher methods were introduced to suppress the black resistance movement. The world reacted in horror and the white minority government became an international pariah, doors closing on the country on all fronts to force it to change its ways. Instead, Government promptly began preparing itself to resist the expected onslaught of the much-feared Communist powers who actively supported the resistance movements. The security forces wanted military equipment to aid in quelling the increasingly effective uprisings within the borders, but were experiencing great difficulty in acquiring such equipment on the open market. Resolved to make the laager secure, Government turned to the black market and to its local technology resources such as the state-funded CSIR and the Atomic Energy Corporation (AEC) to fill the gap.

The country's economy became threatened not only by the effects of its growing isolation and sanctions, but also by galloping inflation. Moreover traditional economic considerations were becoming increasingly irrelevant in the rapidly changing international situation. In response to this dilemma the Government started advocating mechanisms such as import replacement, export promotion and greater national self-sufficiency. The use of locally available raw materials in the manufacture of commodities was re-evaluated in order to compete in the open market. This helped to create a greater awareness of the value of technology and the more effective interaction between the economy and technology.

Against this background Brink scrutinised the relevance of the CSIR's activities with respect to its mandate and government demands. He realised that despite the boom in defence research, a change of course was imminent. Accordingly he focused on the consolidation and rationalisation of the organisation along with the introduction of a number of far-reaching initiatives to improve the CSIR's support of industry.

The CSIR's existing Industrial Economics Division acquired a new focus in line with the current demands and was renamed the Group for Techno-

The site of the CSIR, situated to the east of Pretoria, taken in 1956.

The same site in the early 1990s.

The CSIR Conference Centre which was inaugurated in 1977.

The first executive members appointed to manage the transformed organisation in 1988:
Drs Reinard Arndt, Chris Garbers, Brian Clark and Neville van Deventer.

Directors in training: The management team appointed to head the newly formed divisions at the end of 1987.

Back:

Dr Maurice McDowell *Production Technology*
Dr Geoff Garrett *Materials Science and Technology*
Dr Daan Toerien *Water Technology*
Mr Harry Doeg *Marketing Manager*
Mr Dieter Krueger *Energy Technology*
Mr Johann Ahlers *Microelectronics and Communications Technology*
Dr Johann Fritz *Aeronautical Systems Technology*
Dr Piet Steyn *Food Science and Technology*

Front:

Mr Roy Page-Shipp *Building Technology*
Dr Tony Pizzi *Processing and Chemical Manufacturing Technology*
Dr Brian Clark *Group Executive for RDI*
Dr Jan van Zijl *Earth, Marine and Atmospheric Science and Technology*
Dr Charles Freeme *Roads and Transport Technology*



The three Heads of Centres/Services:
Dr Duncan Martin *Centre for Advanced Computing and Decision Support*
Dr Ben Fouché *Centre for Information Services*
Mr Patrice Laserre *Technical and Site Services*

The Board of 1988
Front:
Dr W P Venter
Executive Chairman, Allied Electronics Corporation Ltd,
Dr C Garbers
President,
Dr L Alberts
Chairman,
Dr L B Knoll
Former Deputy Chairman, Fedmech Holdings Ltd,
Dr C van der Pol
Former Chairman, SA Sugar Association,
Back:
Mr P J van Rooy
Managing Director and Chief Executive, Industrial Development Corporation of South Africa Ltd,
Mr E van As
Group Managing Director and Chief Executive, Sappi Ltd,
Prof D R Woods
Deputy Vice-Chancellor (Research) University of Cape Town,
Mr J A Stegmann
Chairman, Sasol Ltd.

Absent (illustrated centre right):
Dr H B Dyer (Deceased)
Managing Director, De Beers Industrial Diamond Division (Pty) Ltd,
Mr R A Plumbridge
Chairman, Gold Fields of South Africa Ltd.

The Executive team at the end of 1990 after the retirement of Dr Garbers and the independence of FRD. Dr Brian Clark the new Executive President (seated front right) with Executive Vice-Presidents Albert Michau (Finance) beside him, and at the back from left to right Mike Groch (Marketing and Business Development), Fred Camphor (Human Resources), Dr Daan Toerien (Operations) and Dr Geoff Garrett (Operations).

Above: Dr Brian Clark receives the Technology Top 100 Award for 1991 on behalf of the CSIR from the then Minister of Trade and Industry, Mr Derek Keys.
Left: Brian Clark and Jayendra Naidoo were appointed Co-Chairmen of the Science and Technology Initiative which led to the establishment of the National Science and Technology Forum.
Below: The Executive team at the end of 1995.
Left to right:
Mike Groch, Neo Moikangoa, Dr Adi Paterson, Dr Geoff Garrett and Albert Jordaan.

Government office bearers and foreign dignitaries regularly visit the CSIR by invitation or request to familiarise themselves with its activities – a practice that promotes informed decision-taking and ensures that the CSIR is in touch with their needs. Among them are:
1. President Nelson Mandela with CSIR Chairman Paul Kruger and Brian Clark, CSIR President in 1991.

1

2

3

4

5

2. The late Minister Joe Slovo attending a CSIR presentation.
3. King Mswati of Swaziland with Dr Geoff Garrett, current CSIR President.
4. Mrs Margaret Thatcher with Dr Brian Clark.
5. Minister Joe Modise and entourage with Dr Daan Toerien, Director of Manufacturing and Aeronautical Systems Technology and Ingrid Weinert.
6. Zimbabwe President Robert Mugabe attending a CSIR trade exhibition in Zimbabwe.
7. Former State President F W de Klerk, CSIR Council member the late Dr Henry Dyer, and director Dr Daan Toerien.
8. Minister Steve Tswete viewing decision support programmes with Dr Ben Fouché, Director of Information Services, CSIR Vice-President Albert Jordaan and Tina James.

6

7

8

9

10

11

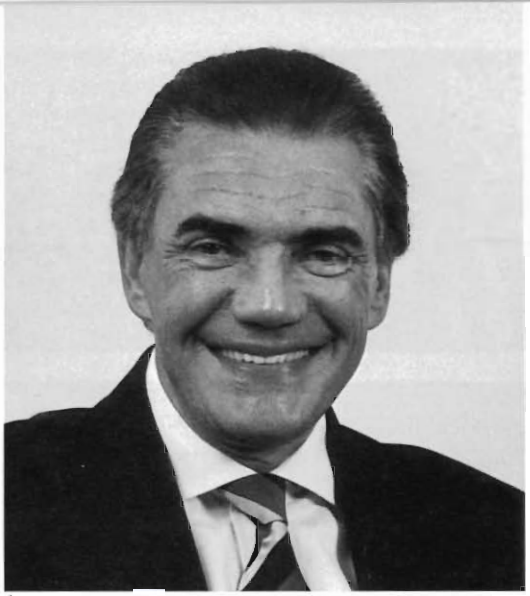
9. Deputy Minister Ronnie Kasrils with Dr Daan Toerien and Dr Geoff Garrett.
10. Premier Tokyo Sexwale and entourage with Vice-Presidents Mike Groch, Neo Moikangoa and the then President Brian Clark.
11. Minister Jay Naidoo with Mr Mike Groch, Dr Geoff Garrett and Mr David Bath, Director of Building Technology.
12. Princess Anne on a tour of the CSIR.
13. Minister Ben Ngubane flanked by Vice-President Mike Groch and Dr Geoff Garrett.
14. MEC for KwaZulu/Natal Jacob Zuma, Minister Valli Moosa, Dr Brian Clark and Paul Kruger.
15. Minister Sankie Mthembi-Mohanyele with David Bath and Aussie Austin of Building Technology.

12

13

14

15



1

2

The CSIR Board, November 1995.
1. Dr Bill Venter
Chairman, CSIR Board, Executive Chairman of the Altron Group of Companies,
2. Mr Les Boyd
Deputy Chairman of Anglo American Corporation,
3. Dr Ivy Matsepe-Casaburri
Chairperson of the board of the SABC,
4. Prof Anton Eberhard
Head of the Energy for Development Research Centre at UCT,
5. Dr Dhiro Gihwala
Director of the Peninsula Technikon's School of Science,
6. Mr Khomotso Phihlela
Manufacturing Development Manager of Nampak Ltd,
7. Prof Friedel Sellschop
Deputy Vice-Chancellor (Research) of the University of the Witwatersrand,
8. Ms Lyndall Shope-Mofole
Councillor of the Independent Broadcasting Authority,
9. Prof Errol Tyobeka
Head of Biochemistry and Acting Head of Research, University of the North,
10. Mr Eugene van As
Executive Chairman of Sappi Limited,
11. Dr Geoff Garrett
President of the CSIR.

3

4

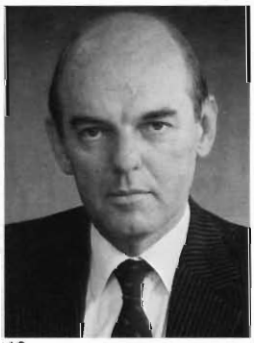
5

6

7

8

9



10

11

Economic Studies. It undertook industrial market research to identify the importance of particular products. Its data bank on import and export statistics helped to increase the demand for contract studies. The establishment of a Technology Development Fund in 1976 to promote research and development in industry was another of the early signs of a market orientation emerging in the organisation.

The CSIR's prestigious collaboration with NASA[13] and CNES[14] in satellite remote tracking gained for itself and South Africa a great deal of credit. The Hartebeesthoek tracking station became one of the busiest in the world network and earned a reputation for reliability. It was judged consistently to be in the top three and often in the number one position.

South Africa's successful participation in international scientific programmes, for example, the International Geophysical Year, prompted the idea of establishing a national body to co-ordinate and manage research programmes locally. National programmes for the environmental sciences, earth sciences, atmospheric and space sciences already existed and were expanding rapidly. Brink established the National Scientific Programmes in 1975, later renamed Co-operative Scientific Programmes (CSP), around these existing activities. The group's role was to identify and define problems peculiar to South Africa, which might require the combined skills of more than one organisation because of their size and complexity. The scope of the CSP was extended to include programmes in Antarctic, marine, materials and energy research.

This initiative promoted joint development projects with industry, other science councils, state departments, museums and the universities. The multidisciplinary approach to problem solving emerged as a key trend, later to form one of the cornerstones of the new CSIR. By 1978 some 600 scientists from 80 South African organisations were involved. Work of outstanding quality was produced, but gradually an unforeseen conflict of interest developed (*see* Chapter 4).

The Production Engineering Advisory Service (PEAS) was launched by the late Dr Tommy Hodgson[15] in 1975 to assist small and medium-sized firms to take advantage of new technological developments. Their main needs were identified as technology transfer rather than research and development. This initiative was taken ten years before the publication of the Government's White Paper advocating exactly this approach, but was on too small a scale to influence the direction of the rest of the CSIR.

In 1979 the Advisory Committee for the Development of Research for Industry (ACDRI) was replaced by ad hoc working groups with specific objectives. For example, the CSIR and the Steel and Engineering Industries Federation of South Africa (Seifsa) formed a group to stimulate innovations

in the metals and electrical engineering industries. A contact campaign was run countrywide and included visits to Taiwan and Israel. The purpose of the drive was to create job opportunities, manpower development, improvement of productivity and technological development for import substitution and export promotion. Among others, these efforts considerably strengthened the technology transfer activity of PEAS.

A National Calibration Service (NCS), pioneered by Dr Dick Turner, was launched in 1980 to improve efficiency in industry.

Another important event during the Brink era was the inauguration of the CSIR Conference Centre. In the early 1950s when one of the CSA meetings took place, it was already evident that the country lacked a modern conference centre that could accommodate multiple sessions and provide services such as simultaneous translation. The CSIR then entered a period of enormous growth but the subject only resurfaced during the 1960s, reinforced by the highly successful conference-organising capability built up by Dr Denys Kingwill. Naudé gave Stutterheim the job to look into the matter and he completed a great deal of the groundwork before he left. The task was then taken over by Vice-President Dr Koos Kemp who did the major part of the planning.

The centre, a showpiece of elegance and advanced technology, was completed in 1977. A suggestion was put forward to call it the Brink Centre, but the Council adhered to its policy of not naming any building after a scientist or personality.

In 1980, when Brink died, the annual budget had increased from R29,3 million (1971) to R102,9 million, and the percentage earned from sources other than parliamentary had dropped slightly from the 1971 high of 37,4%. The drop in percentage income from external sources is relative as the acquisition of institutions such as the SA Astronomical Observatory, the Radio Astronomy Observatory, the Hartebeesthoek Satellite Station and the launching of the National Accelerator Centre tend to distort the picture.

Brink was succeeded by Dr Chris Garbers, a specialist in organic chemistry, in May 1980. Garbers's term of office marks the beginning of an era of continuous change. To appreciate the extent of the revolutionary changes embarked upon over the next decade and the culture shock the organisation was about to absorb, it is necessary to review the culture that had developed over the years and the reasons that led to the momentous decision to transform the organisation.

The Monument 3

Farewell, happy fields,
Where joy for ever dwells! ...

Milton – *Paradise Lost*

RESEARCH UTOPIA

As part of the mission of the newly launched CSIR was to build up a research force of substance, it recruited very high-level scientific and support staff. In line with current Western practice, every effort was made to create a climate in which scientists could thrive, a venture that met with considerable success. As the CSIR gained in stature, universities advised their best science students 'to continue their studies' at the CSIR for two reasons: the universities could not compete with its well-equipped laboratories, and the CSIR had acquired a critical volume of world-class scientists. Many of the university staff came from overseas universities and knew the value of being in an environment where ideas abounded.

Young scientists were encouraged to improve their academic qualifications and were apprenticed to experienced researchers to learn what research was all about. In the process they became familiar with literature studies, learned to work meticulously, to analyse ruthlessly and objectively, to cope with disappointments when their first efforts didn't work out, that negative results also contributed to knowledge, above all to persevere, and to record their results faithfully to stand up to international scrutiny. Their mentors had the same status as university professors and young researchers 'sat at their feet' much like students. To gain acceptance to the elite circle of senior researchers required hard work and dedication, and

often took up to a decade to achieve.

The first two decades of the CSIR's existence coincided with the tail end of the Golden Age of science worldwide. It was the era of spectacular technological developments, the launch of the first spacecraft, the promise of the wonders of nuclear power, the discovery of the double helix and the development of the microchip. Students were keen to make a career in science and vied for the privilege of working at the CSIR – the exciting experience of gaining new knowledge, moving the boundaries of the known ever further, to be one of the pioneers working at the frontiers of science.

At this stage science was not yet seen as something with evil connotations such as pollution or radiation associated with the destruction of mankind. Science had status and the CSIR was the local star. This positive picture was however often offset by the lower salaries the CSIR could offer in comparison with private enterprise. Some successful and ambitious young scientists, who refused to accept the pleasant environment and working conditions as part of their compensation, were enticed by better salaries in the private sector after gaining valuable research experience at the CSIR. Management wasn't unduly perturbed by this unscheduled technology transfer. It was seen as part of the CSIR's brief, namely to provide a training ground for people who would eventually make a contribution in industry. This cross-pollination also served to strengthen relations between the CSIR and industry.

Up to the early 1960s bursars actually signed their contract with the CSIR in the President's office, with the President presiding, and discussed career prospects. The organisation was still relatively small and the laboratories' identities had not yet grown as strong as they did later.

The common bond of 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.

In the early years the CSIR served as a home from home for most of its staff with the well-equipped recreation site as its social nerve centre. During lunch staff played cricket or bridge, or went for a quick swim, adding to the camaraderie. This custom tailed off later when subsidised meals were supplied, the working hours changed and the lunch period was reduced to 30 minutes.

Because the site was situated some distance from the city and public transport was virtually non-existent in the area, a fleet of special CSIR buses ferried employees to work and back all over Pretoria. This special arrangement with the municipal bus service was subsidised by the CSIR. Cars on campus were few and mostly utilitarian. It was a standard joke that the mod-

estly salaried CSIR employee could claim two-car status. The vehicles in question were usually an ageing Peugeot station wagon and an equally mature Volkswagen Beetle.

The staff newspaper, *Sciendaba*, started in the early 1960s reflected this relaxed happy family character. Because of the appropriateness of the name, symbolising the organisation's European and African roots, it survived even the clean sweep revolution of two successive transformations.

The CSIR became a mini-paradise in which to work. The physical environment was superb and during the early years all the positive aspects of the 'university without students' could be enjoyed to the full. The pursuit of fundamental research was encouraged, while the CSIR worked closely with industry, thanks to the personal efforts of its directors. The nature of the field scientists worked in often determined whether they would be doing fundamental or applied work. Areas such as the engineering fields, water and building technology by their nature operated much more closely to industry and the marketplace.

A good example of a partnership between basic and applied research was the study done on cement that formed blisters upon setting. The fundamental study of the dehydration of cement was referred to the basic disciplines. The eventual outcome was the development of a cement, called slagment, that made use of a waste material associated with steel works which posed an environmental problem. The research path was from the practical to the fundamental. (The present approach is that fundamental research can enter the product development process at all stages of its cycle.)

The concerted effort to address problems of national importance was supported by an excellent library, built up to form a national facility of repute. Contact with the universities in the vicinity was encouraged by regular seminars.

Because of the limited number of technical support staff, researchers had to do a variety of development work themselves, from building their own equipment to the highest level of technological innovation. Scientists from Europe were usually highly agitated by this lack of technical support. This was not necessarily a disadvantage, because researchers developed a breadth of skills which perhaps bred a greater understanding for problem-solving than their counterparts in more privileged and technologically populated environments. All in all it was a thoroughly stimulating and unique environment produced by the single-minded pursuit of knowledge, where the elusive quality of research intuition could be cultivated.

The sheer pleasure of cracking tough problems that characterises research environments was multiplied by the challenge of building up a world-class research establishment in a relatively insignificant country. Re-

searchers voluntarily worked long hours, often coping with shoestring budgets that challenged their innovative abilities to the limit, in their enthusiasm to create a monument to excellence.

They succeeded beyond their wildest dreams. Those who were exposed to research environments abroad returned with a vision of what the CSIR should be and went about achieving it with dedicated professionalism. The resulting science and technology infrastructure provided industry with a resource unique on the African continent. Unfortunately, instead of concentrating on a few key issues, the tendency was to spread the resources over too many activities. Growth was random, not part of an overall plan. While the organisation was still fairly small, it was easy to manage small groups of researchers. They did good work and few questions were asked. They could indulge their curiosity without worrying too much about time constraints or practical results, and take pride in the publication of research findings, sometimes of a very esoteric nature, in prestigious international scientific journals. The research corps nurtured in this environment more than held their own in the international scientific community.

EVOLUTION AND MUTATION

Inevitably the glamour associated with science at the time, the favourable working conditions and the practically unrestricted freedom to pursue knowledge created an elitist culture. If power corrupts then so does too much freedom. The research Utopia became a wonderful playground and gradually a more academic approach to research took over. By the late 1960s the trend was to do own-choice research as long as it was good. This was a widespread, although not exclusive, phenomenon in the CSIR.

The prevailing approach to science is epitomised by Brian Clark's experience as a young laboratory assistant in 1966.[1] Working on the melting point of ice under extremely high pressures, he was asked by a visitor what the point of it all was. At a loss for an answer, he consulted his departmental head who told him he should have replied with another question: 'What right have you to ask such a question?'[2]

This philosophy had its roots in the heady approach to research adopted in Western Europe. Dr Eric Halliday recalled a toast popular in the undergraduate scientific circles of Cambridge at the time: 'Here's to research – and may it do nobody any good!'[3] According to Dr Halliday, '(the toast) expresses a belief and a protest: a belief that scientific research is worthy of honour in its own right, and a protest against attempts to make research activities purely utilitarian; a protest against applied research, and above all a protest against "directed research".'[4]

An example of successful investment in a new technology was the es-

tablishment of a laser research activity at the CSIR in the late 1960s.[5] At that stage, the laser was generally described as 'a solution in search of a problem'. Today laser technology is used extensively in industry, in medicine, for accurate measurement, CD players, and even for such mundane applications as the cost-effective drilling of holes of consistent size in teats for baby bottles. The fact that advanced expertise in laser technology is available locally today is of great advantage to the growing number of industrial users in this field.

For almost two decades the vision of Smuts and the status of science during its Golden Age had created a momentum, a favourable climate in which research for the sake of knowledge could flourish. The view that a country's top scientific brains should be supported to pursue just this was generally accepted and remains the ideal of many academics.

In their constant pursuit of knowledge, scientists retain something of the child, the sustained wonderment of discovering the world. This is responsible for an element of naïvety in their make-up, a total disregard sometimes for mundane things like order, personal appearance, status symbols, material things, convention and authority. For the most part, serious researchers were modest, unpretentious people, with an enormous capacity for fun, who played games with the CSIR's bureaucratic system, finding ingenious methods to circumvent and frustrate it. Such an environment can also literally breed prima donnas, complete with tantrums and eccentric behaviour in general.

Imagine the immense shock of having to convert to a business culture. Naïvety puts you at a disadvantage in negotiating contracts; tantrums and a disregard for convention will lose you customers; a smart appearance is associated with commercial success; and being experts in their fields, it was doubly difficult not to tell the customer what he needed. In the main technical advice had been given quite freely and the idea of selling knowledge was generally considered anathema.

It may have been affordable in the 1950s and 1960s for individual countries to do unfettered research, but economic constraints and the extent of technological needs demanded a more realistic approach. All over the world national research laboratories were going through this evolutionary process. In South Africa the process was influenced by mutational forces unique to its own particular politics and demographics.

The CSIR practically drowned in its own success of the first two decades. As it grew bigger and became more successful, arrogance and complacency set in and State funding to the tune of two thirds of the annual budget created a climate of invincibility. Inevitably, such a climate would give rise to a lack of focus in research.

The freedom to pursue new knowledge is exciting stuff, but must be properly managed. Under the old dispensation it could easily be abused for personal glory, or simply for producing very little, as the culture of 'independence of thought and freedom of action' demanded an integrity sometimes beyond the reach of mere mortals. This philosophy did pay dividends, but far too few, and the practical results were not made visible enough. The shift in emphasis to own-choice research did nothing to counter the image of an unproductive operation that was building up in the public's perception of the CSIR. Despite its international reputation, or perhaps because of it, the business world generally regarded the CSIR as a bunch of boffins, totally out of touch with the real world, whose learned papers were of little relevance to local industry. And in all fairness, they had reason.

By the mid-1960s the pattern of government interference in the administration of the CSIR was well established. The initial freedom to establish a competent scientific workforce had gradually been eroded as the responsible government departments increasingly referred administrative matters to the Public Service Commission (later renamed the Commission for Administration).

The practices it imposed on the organisation were beginning to manifest as a civil service culture, characterised by incremental salary increases irrespective of performance, by hierarchical titles that bordered on the absurd, a clock-watching atmosphere, where traditional privileges eventually come to be considered as sacred rights, aided and abetted by the CSIR's own practice of subsidised buses and meals.

Management in those days was equated with administration. CSIR managers, mostly drawn from universities, shared this approach with their academic counterparts. They traditionally resented their administrative load, which in fact was an essential management function. Researchers didn't want to dirty their hands with administration and so invented the function of an institute secretary. He became the person who could say whether or not there was money available for a project, while heads of departments indulged their research interests to their heart's content. Some directors, and even the President at one stage, had their own laboratories where they pursued pet projects. Thus it was the researchers' own fault that the internal administrative departments became so strong. The institute secretaries and the head office equivalent managed the CSIR without being in a position to give research leadership. The Executive spent their time allocating capital equipment and became involved in the micro-management of the institute's research activities, severely affecting the authority of the directors.

Still for many of the country's brightest science graduates, the CSIR represented a lofty place where there was a challenge to change things, to make a difference, where money was available to spend on useful technological projects that could benefit the country, and maybe even the world. The CSIR was and still is seen as part of the country's essential infrastructure, like a good transport network – 'the railways of science', as one member put it.

In the prevailing culture, however, it depended very much on the individual whether he could discipline himself to exploit the favourable environment to the full or slip into a sheltered employment mentality. The massive bureaucracy of the civil service management style could be a damned nuisance or provide a safe hiding place, depending on what you wanted to do with your life.

Thus the scientists' Utopia eventually lent itself to harbouring unproductive passengers and, in addition, gradually lost touch with reality, both local and global. On the credit side, outstanding work had been done in support of industry and the national infrastructure, and a solid reputation for scientific excellence had been built up. A sound core of quality people saw to this and upheld the good tradition.

Another drawback was a consequence of the inflexible reliance of many scientists on their own judgement and knowledge, which created a culture in which nobody accepted or trusted anybody else's ideas or instructions. It was the era of 'publish or perish'.

The environment became competitive to an almost destructive degree. This resulted in turf protection and the inefficient and expensive duplication of work. Work-team spirit was lacking, teamwork being equated with socialising, getting on well with one another, the 'old school tie' syndrome.[6]

Managers were openly criticised, reinforcing the prevalent *laissez-faire* management style. Management information systems, measures to ensure occupational safety and health, formalised management of finance, administration and personnel were considered to be bureaucratic measures not applicable to scientists, and their perpetrators to be of lesser status.[7]

The gradual slide into subservience to the Commission for Administration and the political demands of Government did nothing to improve the situation. However, the feeling of having Government on your side probably contributed to the prevailing arrogance among consenting researchers. Personalities started playing a more prominent role in the practising of science and professional jealousy and empire building became more evident.

In the political climate that prevailed during the third and fourth decades of the CSIR's existence, two trump cards held sway over the direction and

funding of research: on the one hand the uranium enrichment effort, and on the other, the defence research effort. The former held no advantage for the CSIR, but it certainly benefited substantially from the latter. Prestige in Parliament started counting for more than the value of science, as this was where the level of funding was decided. Science became the financial slave of politics.

Although substantial applied research was carried out, especially in the fields of food, building, road construction and water technology, the bias developed towards research work aimed at either the international audience or alleged national strategic requirements.

After South Africa became a republic in 1961, the emphasis on defence research increased steadily. By the early 1970s the pattern was well established. This research work was done under contract to the SA Defence Force or Armscor and its affiliates.[8] Researchers involved in this kind of work experienced the discipline of managing projects, meeting deadlines and working within budgetary constraints. They experienced the satisfaction of seeing a project through from doing the fundamental research to the actual production of a useful item that conformed to specifications, often comparing more than favourably against international competition. Many of them became frustrated with the prevailing culture which measured progress against the publication of research papers in prestigious journals. Their experience of competing in the real world would later serve the CSIR well in the process of transforming itself into a market-driven organisation.

Researchers who were exposed to similar research organisations abroad during the mid-1970s observed a shift in emphasis to more applied research and the erosion of the elitist approach. The endless frontier concept had come to an end and questions arose about how to maintain a creative environment while working on more practical things.[9] Scientists who were interested in fathoming the reasons for success in the changing environment, for example, the excellent record of American researchers or Japan's industrial success, started reading more widely than the specialist scientific literature. They sought out papers on successful human resource management, project management and relevant business practices in order to gain a broader understanding. Industrial research required management, human and business skills. The CSIR had gone to great lengths for young researchers, providing them with opportunities, for example, enabling them to take up postdoctoral appointments, but did little to assist in their broader development.

With hindsight it is easy to trace these events that influenced the evolution of research organisations in general and the CSIR in particular. To

name a few, the circumstances that determined the character of the CSIR with its institution, the subsequent role of government, the international isolation, the human factor and the absence of a management culture. Armed with this wisdom, it now seems a pity that the CSIR had not been given some teeth with its foundation. There was no formal mechanism to enforce the implementation of the excellent research achievements, which was after all what the taxpayer invested in. Pioneering work had been done on road building, but new roads still fell apart as a result of the increase in heavy vehicle traffic. Part of the new Witbank highway in the 1960s started crumbling within a few weeks of its opening – in all probability a disaster that could have been averted by exploiting the available expertise.

This was not the rule, but the fact that valuable research reports often gathered dust while preventable and costly mistakes were being made, points to flaws in the system. There was too little co-ordination and communication between scientists, government and industry on technology supply and demand to ensure an acceptable return on investment of funds specifically allocated to support local technology. Where a representative from industry or a government department had collaborated in a joint project, the implementation of results fared much better.

Had something been written into the founding Act from the outset to ensure technology transfer, the emphasis may well have been stronger on applied research. Visibility of the role of the CSIR and its value to society would have been better, and the demand for its technological services may have provided its own momentum.

As the CSIR moved away from its original brief of doing research in support of industry, its image waned accordingly. When dealing with the public or private sector, the system did not foster a sense of urgency. Such organisations wanted problems solved promptly and could not wait for the leisurely machinery to be set in motion to construct a research project that might yield results at an undetermined date. Such experiences strengthened the view that the CSIR had lapsed into an ineffective mode bred by the culture of sheltered employment even further.

South Africa's isolation also impacted on the scientific community. The worldwide debate on the value of science resulted in an increased emphasis on implementation. Those researchers who observed the trend tried to spread the new gospel, but progress was painfully slow. The CSIR was lagging about fifteen years behind by the time real action was taken.

The establishment of the Advisory Committee for the Development of Research in Industry (ACDRI) by the Council was an attempt in the 1970s to achieve a better balance. The introduction of scientific advisory com-

mittees to each institute was another initiative in this regard. Despite their sincere and often exceptional contributions, the committees had little accountability or ownership, and their value was virtually reduced to that of a debating society. To make matters worse, some unscrupulous scientists exploited the system by quoting the committees' authority to gain acceptance for their pet projects.

The all too common phenomenon of empire building was as prevalent at the CSIR as in any other large organisation. Although it has healthy connotations of providing the motivation and drive to get something off the ground, it inevitably has its negative side. From the outset empire building was one of the biggest sources of growth and trouble for the CSIR. Personal ambition and aspirations, hitched onto the handy wagon of a scientific discipline or research area, sparked off severe professional rivalry and the foundation of many a new institute and even statutory bodies.

This random growth pattern resulted in an organisation that was eventually made up of groups of institutes that were either discipline-oriented, profession-oriented or sector- oriented, all with different criteria for measuring success. Management of such a mixture would clearly be extremely difficult.

Once these institutes were established, turf protection came into operation. Combined with the entrenched tradition of Western research practice, this probably doubled the resistance to change. Only financial reality and the dogged determination of the change managers to drive the change process were able to coax the ship onto a different course.

The Council had even less teeth. Council members found their association with the prestigious organisation both gratifying and frustrating. The President, as Chairman of the Council, largely determined the direction of the CSIR and was able to put his personal stamp on the organisation (*see* Profiles). While the CSIR was still being built up, this centralisation of power provided coherence. Later on, along with the growing control exercised by the public service, it all but neutralised the Council's real function.

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 its scientific papers, the only publications communicating the CSIR's progress and value to the country were the annual report to Parliament and a quarterly journal, *Scientiae*, aimed at the the general public, but with a limited circulation.

Because their ability to influence the established course of the CSIR was limited, members of the Council paddled their own canoe. Those representing industry used the opportunity to channel money to their particular

area of interest, whether it was engineering, textiles, mining, or whatever the composition of the Council was at the time. There was no co-ordinated plan to serve industry or establish whether the services available were really what industry wanted. The CSIR measured its success by international publications. The rest of the Council members, representing other statutory councils and the universities, were perfectly comfortable with this traditional approach.

Alarm Bells 4

Our remedies oft in ourselves do lie.
Which we ascribe to heaven.

Shakespeare – *All's Well that Ends Well*

STORMY WEATHER

When Dr Chris Garbers took up the reins in May 1980, the waters had become even more turbulent. Persistent inflation, a worldwide recession, the aftermath of the energy crisis, the weakening price of gold and the onset of severe drought, all contributed to a particularly unfavourable climate.

Dr Brink's initiatives to adapt to the changing circumstances had to be continued, but an even more imaginative strategy was required to ensure that the CSIR could fulfil its duty of extending the benefits of science and technology to the whole of South Africa, the dilemma of the country's dual economy still unsolved.

The increasing political awareness of the disenfranchised black population during the 1980s focused attention on Government spending among other things. In an attempt to curb expenditure and increase productivity in areas partially or totally funded by Government, substantial budget cutbacks were introduced and the concept of deregulation arose. The reduced Parliamentary grant affected the CSIR severely. To make matters worse, the public service increased its attempts to exert greater administrative control over the CSIR.

On the international scene intense trade competition realerted entrepreneurs to the strategic and commercial value of science. Science and technology policy was constantly under worldwide scrutiny in order to squeeze

out every drop of competitive advantage that science could offer. Attempts to formulate a suitable science and technology policy in South Africa had not been very successful, partly because Government failed to create the right conditions. Generally, a more outward-looking export-oriented climate is fostered by encouraging business through venture capital and tax incentives to exploit innovative technology. Most members of the scientific community for their part were locked into the publish-or-perish culture and exercised very little influence on national science and technology policy.

Garbers was already aware of tensions when he joined the organisation two years previously to manage the university research grant portfolio. The prevailing external and internal forces confronting the CSIR needed to be thoroughly analysed. Over the next seven years a number of events prompted further introspection that culminated in the actions that would ultimately revolutionise the organisation. In the long run it was no good treating the various symptoms individually without addressing the root causes of the problems. It became evident that minor surgery might not be enough to meet the future challenge.

Against this background other external factors that influenced the thinking to introduce change were the findings of the Riekert (1979) and Wiehahn Commissions (1982),[1] the recommendations of Professor Jack de Wet (1983) on national research funding of the natural and engineering sciences,[2] the Kleu Report (1983) which preceded the White Paper on an *Industrial Development Strategy (1985)*,[3] the budget cuts imposed by Government, and the criticism levelled at the CSIR from outside and by its own staff.

NEGOTIATING THE RAPIDS

The Riekert and Wiehahn Commissions focused renewed attention on legalised discriminatory practices in the country. An increasing number of staff were criticising the practising of apartheid within the organisation at both the social and professional level. During the late 1970s ultra right-wing members made an attempt to amend the constitution of the Employees' Association to exclude blacks. When Brink heard about this, he immediately summoned the perpetrators and vetoed any such move; in fact he closed down the association. When the members claimed that it had acquired certain assets and could not simply be wiped off the board, he ordered a cheque to be issued on the spot for the amount in question.

Brink suffered a fatal heart attack in May 1980 and it was left to Garbers, who took up the reins, to continue with the reformation of the association. He instructed the members to work out a non-discriminatory system and set about desegregating social functions and opening up

amenities to all employees.

Providing suitable accommodation for visiting scientists and black students was a perennial problem to address. The CSIR had acquired a block of flats in Silverton which provided interim affordable accommodation for the steady stream of scientists it brought in from abroad during the early years, as well as for visiting scientists and bursars doing vacation work at the CSIR.

As the block of flats was situated in a so-called white area, it could not be used to accommodate visiting black scientists and bursars. To deal with this situation, management decided to provide accommodation on its own premises and to negotiate that the CSIR's Pretoria premises be declared an 'Open Area'.

Until such permission was obtained, the CSIR made use of Indian, coloured and black families in Pretoria who took in pupils from rural areas driven by the ambition to attend good schools in the cities. These families willingly accommodated the bursars during the school holidays, and when the schools reopened, they were transferred to international hotels. In addition, special arrangements had to be made for transport as buses were also segregated. As the end of apartheid was not yet in sight, the provision of accommodation on site seemed to be a practical solution.

Once Open Area status for the CSIR had been granted, 24 residential units were built close to the Conference Centre. Situated in one of the most scenic spots, the Entabeni complex is still a much-appreciated and useful asset to the organisation even if its original purpose is mercifully no longer an issue.

During the mid-1980s the Executive formulated an equal opportunities policy which met with limited success at the time but at least laid the foundation for its subsequent affirmative action programme.

The conflict of interest that had developed around the Co-operative Scientific Programmes (CSP), mentioned earlier, needed to be resolved. Looking at the history of national research funding at the CSIR, its handling changed under each successive president. Under Schonland, applications for such funding were screened by university committees and sent to referees for evaluation. Naudé introduced specialised university committees for the evaluation of applications and the allocation of funds. During Brink's office, Council delegated the management of the funding to the Executive to be handled by the University Research Division under the supervision of a vice-president.

Brink initiated the concept of the CSP to promote goal-directed programmes designed to solve problems of critical national importance. The CSP formed an autonomous entity, distinct from the University Research

Division, and was under his direct supervision. While the concept of the CSP was sound and demonstrated a drive to promote research of direct relevance to the country's needs and an understanding of the emerging multidisciplinary approach to tackle problems, it eventually strayed from its co-ordinating role.

The CSP managers, who reported to the President, drew on current projects in the CSIR and ran them at corporate level. Many South African scientists, accustomed to working independently, resisted the leading role these managers assumed. On the other hand university researchers, themselves under increasing financial pressure, were attracted by the well-funded CSP contracts allocated for large goal-directed research projects, while their function was more in line with the lesser-funded basic research projects sponsored by the University Research Division (later renamed the Research Grant Division). The rapid growth of the CSP's national programmes therefore occurred to some extent at the expense of the division and the imbalance caused concern. Hindsight suggests that Brink could not persuade the CSIR institutes to do work of more relevance to the country's needs and this was his way of dealing with the matter.

As part of the CSIR's mandate was to manage the funding of special research projects in the national interest, it negotiated on its own behalf as well as on that of the universities. CSIR institutes were convinced that the lion's share was going to the universities, while some members of the universities, despite extensive consultation with their representatives in fulfilling this function, questioned the CSIR's objectivity and criteria in allocating the funds.

When Brink passed away unexpectedly, Garbers used the opportunity to remove the presidency from the line function of the CSP. Both the research funding portfolio and the CSP were entrusted to Dr Reinhard Arndt.[4] To put the matter of national research funding on a more sound footing, Garbers and Arndt co-opted Professor Jack de Wet to investigate the options.

De Wet recommended that the Research Grant Division be converted into a Main Research Support Programme which was to undertake a far more critical evaluation of researchers in their entire professional capacity. Because of De Wet's sound professional reputation and experience in an environment where research flourished, he was able to devise an evaluation system for research quality that adhered to international standards and favoured outstanding researchers. Progress and academic achievement were carefully monitored to ensure that research funds were invested wisely. The emphasis on quality research led, in fact, to an increase in funds for prestigious research. It also alerted individual universities to monitor the quality of their own funded research. However, among the science and

technology community there were reservations about the emphasis on good individual researchers as it sometimes occurred at the expense of research projects in the national interest.

As a result of De Wet's recommendations the Main Research Support Programme and the Co-operative Scientific Programmes were combined to form the CSIR Foundation for Research Development (FRD) in 1984, headed by Arndt.

The Kleu investigation was commissioned in 1977 to establish productivity in both the private and public sectors. Kleu also identified the areas in which South African industry had a chance of competing internationally given a bit of assistance. The Kleu Report was completed in 1983, and the message it conveyed served to strengthen the hand of those researchers at the CSIR who for many years had been devoted to research of more practical relevance to the country's economy.

CSIR management read the big print on the wall. In anticipation of the White Paper that was to follow the Kleu Report, Garbers sent out a letter to all chief directors in 1984, appealing to them to check the relevance and viability of their various portfolios and to guard against the duplication of work among the institutes. As encouragement he pledged financial support to compensate for costs incurred by the rationalisation of research projects. For those steeped in the long tradition of unfettered research, many in senior positions, it was almost impossible to be objective about their traditional and pet projects. Entrenched practices, turf protection and an inability to see the big picture demanded a radically different approach, a clearly defined and co-ordinated alternative.

Government appointed an industrial advisory committee to draw up the White Paper on an *Industrial Development Strategy* based on the findings of the Kleu Report. With budget cutbacks looming, the initiative sparked off intensive lobbying by interested parties to be identified in the paper as crucial to the implementation of the report's recommendations.

Inherent in its name and empowered by law to support industry through research, the CSIR was the logical instrument for technology transfer as defined in these recommendations. When the White Paper was published in May 1985 it specifically mentioned the CSIR's pivotal role in transferring technology to both the public and private sectors.[5]

As a result of the series of changes initiated during the Brink era, and in response to ongoing demands from industry, the CSIR had already taken the first steps to becoming increasingly involved in technology transfer. The process would however have to expand and be accelerated considerably.

The White Paper was not specific in spelling out how its recommenda-

tions should be accomplished and left the interpretation to the discretion of the various research bodies. The Council urged the CSIR to seize the initiative. After extensive consultation with Council members and key staff, the Executive decided to convene a meeting in August 1985 to be held in Rustenburg at which top management and selected figures in industry would be asked to come up with an appropriate strategy.[6]

The ever-critical workforce were voicing their unhappiness on a growing number of issues. As this too was seen as a signal for change, the Executive used the opportunity to obtain these views in preparation for the proposed Rustenburg meeting. Consultants were brought in to draw up a questionnaire, which was distributed throughout the CSIR in June 1985, to assess the nature and magnitude of the problem. A pattern of widespread frustration emerged.

Frustration with salaries and the prevailing bureaucracy could be traced to the heavy hand of the Commission for Administration, and came as no surprise. Lack of funds for fundamental research was the drum beaten by the old school, while the young Turks' rallying cry concentrated on the management structure and the relevance of research content to the marketplace.

Another alarm bell was the huge losses being made by the CSIR technical workshops. Initially all equipment was made on site. Despite the fact that eventually much of this equipment could be bought ready made, the workshops were still turning out some of the required equipment on demand.

Top of the list, however, was the frustration with the centralised management structure. The CSIR Executive had grown over the years and had gradually assumed control over the management of the institutes. Already beset with the problem of retaining key scientists, this erosion of their authority further added to the frustration of institute management.

Following the popular custom of the business world of isolating its leaders in a remote area to thrash out important issues, the CSIR's meeting in Rustenburg marks the first in a series of *bosberade*[7] at which the destiny of the CSIR was to be irrevocably changed. Armed with the message of the White Paper and the results of the staff survey, the purpose of the meeting was to look critically at the functions and structure of the CSIR and where it should be in five years' time. The main topic was how to address the function of technology transfer.

Chief Directors, Dr Duncan Martin and Mr Naudé van Wyk were tasked with drafting a document on the outcome to serve as a basis for discussion with the Department of Trade and Industry, after which it would be submitted to the Minister. Following his approval, a strategy and plan of ac-

tion would be drawn up and cleared with the various interested parties, including the Department of Trade and Industry, SA Inventions Development Corporation (Saidcor), National Productivity Institute (NPI), SABS, IDC, Small Business Development Corporation and the Board of Trade and Industry.

At this stage the proposed initiatives concentrated on a concerted drive, in collaboration with the Department of Trade and Industry, to increase contact with industry in order to establish their needs and growth potential, and to launch a proactive information campaign directed at suppliers and developers of technology to communicate these needs. The longer-term aim was to promote industrial research among all research and development communities.

One of the options considered for the CSIR to fit into this scenario was the creation of a Foundation for Technology Development, a concept the Council rejected without hesitation. Council members had been agitating for more radical change since the appearance of the Kleu Report in 1983. Thus various mechanisms (*see* Chapter 5) were set in motion to review the management and mission of the CSIR so as to come up with a viable and dynamic alternative.

Following the staff survey, leading young Turk Brian Clark undertook a detailed study of the CSIR's management structure. As Chief Director of the National Institute for Materials Research, Clark was tasked to draw up the institute's budget. The imbalance between his responsibility and the limits of his authority was debilitating, and he was determined to do something about it. He consulted with his fellow directors and Executive and submitted a report on the findings and recommendations towards the end of 1985.[8]

The result was a hard-hitting document that showed up the laborious process decision-taking at the CSIR had become. The centralised bureaucracy had the Executive embroiled in operational management decisions related to the institutes, which left them little time to devote to policy matters. This in turn meant poor utilisation of highly qualified staff in management positions.

The Administrative Services Department (ASD) had gradually assumed a line function with the emphasis more on prescriptive control than on service. The administration was tight, clean and big. It often happened that administrative functionaries with little or no knowledge of specialised scientific fields would impose decisions on the actual experts. The centralised control function prevented institutes from making full use of available funds and adapting quickly to changing circumstances. The recommendations for change were phrased around these findings.

The seeds for this report were sown some ten years previously when Clark

was appointed head of High Pressure Physics after the untimely death of Dr Carl Pistorius. The appointment did not add one cent to his salary, nor was there any official policy or mechanism to provide him, aged 27 and with no management experience, with training for his task. This was typical of the approach to management at the time.

Such was the culture of the old CSIR that increased responsibility did not warrant increased remuneration within the rigid financial constraints imposed by the Commission for Administration. Nor was it even considered necessary that anyone so highly qualified in science should need such mundane business skills to control budgets and manage complex projects, not to mention human resources. Even at the highest level, managers were appointed without being told what was expected of them, being left to operate in a vacuum for most of the time.

On the one hand, management probably acted in the naïve belief that highly qualified scientists were capable of handling anything. On the other hand, the concept of management as a discipline in its own right had not filtered through to the science-dominated environment of the old CSIR. In any case, the financial and human resource systems were prescribed in such great detail by the public service, and applied with well-intended efficiency by the ASD, that these functions were rendered purely routine.

Respect for management was further eroded by the pettiness of the current bureaucracy. For example, productivity could be severely affected by staff being required to look for capital items, sometimes worth a trivial amount, for days on end during capital stocktaking. The institute secretary, empowered to execute the administrative policy, could enforce this, as the rule book said it was impossible to write off an item unless it could be found!

The recommendations for improving the management structure were designed to eliminate the obstructive and emasculating effect of the old centralised bureaucratic system. Their implementation represented the first step towards revolutionising the entire CSIR structure.

The initiative Clark had shown in challenging and analysing the management structure as well as his leadership in taking the CSIR's materials activity along the industrial research route, marked him as the ideal person to lead the CSIR's technology transfer process. He was unanimously appointed Deputy President by the Council in January 1986 with the specific task of driving the CSIR's technology transfer initiative.

An enormous effort went into freeing the CSIR from the Commission of Administration's stranglehold. To appreciate how the prevailing bureaucracy at the CSIR had evolved, some aspects of the administrative system imposed by the commission on the CSIR and its response to its application are highlighted. The Commission's prescriptive approach which imposed

civil service structures and job categories on the CSIR severely hampered its ability to pay competitive salaries to key scientists and in effect gave the entire administration a bureaucratic cast. The Commission was moreover not consistent in meting out these injustices. When the various statutory bodies were compared, a severe imbalance was evident. If the budgets, personnel and volume of obligations were weighed up against the top structures that were to manage all this, the CSIR was vastly undersupplied according to the established norms.

Over the years the CSIR had succumbed to the civil service practice of structuring its hierarchy to a ridiculous level of subgradations – chief director, director, assistant director, senior chief researcher – in an effort to gain the associated privileges for its staff. To improve the situation, Garbers consolidated the vice and deputy presidential functions into a single rank in the hierarchy, a step that had a domino effect on the ranks lower down, all moving one rung up the ladder. Apart from improving the salary scales of managers, the benefits of the newly introduced car scheme were also able to reach deeper into the organisation. The Committee for Service Conditions for Science Councils fully supported these initiatives and claims of the CSIR.

The enforcement of a new system, the Personnel Administration Standards (PAS), which determined salary levels, put even more pressure on the CSIR. Strict application of the system led to loss of key personnel, loss of morale among senior personnel and frustration of management in executing their approved mandate under its restrictions. The Executive embarked on a campaign to obtain a mandate to dispose of its budget according to its needs and started operating as if it had. The Commission for Administration reacted strongly by requesting a record of everything that had been paid out. Garbers managed to persuade the Director-General of the Department of Trade and Industry to defuse the situation. Despite his intervention the matter was later referred to the Standing Committee for Unauthorised Expenditure, headed by Mr Harry Schwartz. He promptly assessed the matter: 'Let's get rid of this mess,' he said, and authorised the alleged unauthorised expenditure.

In the wake of this reprieve, the CSIR sent the Commission every bit of paper dealing with expenditure on salaries to underline the absurdity of their micro-management. The Commission simply did not have the manpower to handle it. The CSIR had never overspent its budget or failed to adhere to the prescribed remuneration system and the whole exercise was aimed at more effective management of funds.

The Council lobbied vigorously to win more autonomy for the CSIR and made sure this message got through to the appropriate authorities. To

them it was a revelation that the CSIR did not want more money but simply the freedom to administer the funds according to its own priorities. The then Minister of National Education, FW de Klerk, was quick to grasp the absurdity of the situation and ordered governance structures to be tidied up. The result was the introduction of a system of framework autonomy, which tied in with Government's bid towards deregulation. Inadvertently, the introduction of framework autonomy created the space for the CSIR to embark on its revolutionary course.

Charting a New Course 5

There is a tide in the affairs of men
Which, taken at the flood, leads on to fortune;
Omitted, all the voyage of their life
Is bound in shallows and in miseries,
On such a full sea are we now afloat,
And we must take the current when it serves,
Or lose our ventures.

Shakespeare – *Julius Caesar*

ALL HANDS ON DECK

The decision to change had originated from the CSIR itself and had been taken at the insistence of Council, who grabbed the opportunity to do away with their previous rubber stamp routine. The Executive selected a firm of professional consultants to assist it with the task of accelerating the technology transfer process. The consultants were charged to investigate an appropriate structure for the CSIR to fulfil its obligations, the possible privatisation of selected activities, and to advise on a suitable management style.

A further independent consultant was appointed to investigate appropriate business structures. He held interviews with the Executive and chief directors, obtained the views of private enterprise, state corporations and relevant government departments, and studied the interaction of the CSIR with its major stakeholders. His recommendations included that the CSIR should formulate a five-to-ten year plan; adjust its emphasis from research and development to implementation while ensuring a proper balance between research for knowledge and technology development and transfer; retain the strengths in technology transfer that it had developed over the years; develop business skills in the workforce; and form a technology and transfer company that would absorb the current South African Inventions Development Corporation (Saidcor), with equity being held by the

Industrial Development Corporation (IDC) and the CSIR.

The Council entered into the dynamic planning phase with gusto. Those representing industry were on home ground, their function now more in line with that of the board of a private company. Much to the benefit of the CSIR, some of the members had extensive experience of organisational change and could contribute actively to shaping the future of the CSIR.

As President, Garbers started defining the CSIR's role in his communications in decidedly more outward-looking terms than had become customary over the previous twenty years. His speeches started positioning the CSIR 'as a tremendous national asset which with its knowledge and expertise can, at short notice, tackle complex scientific problems as well as everyday practical problems'.[1] He also emphasised the potential contribution the CSIR could make in Africa.

In short, where the emphasis had been steadily increasing on research and development over the previous two decades, it had to be deliberately shifted to the implementation of research results and the application of existing knowledge. To fulfil this role the CSIR would have to cure its operational ills and make a major adjustment to develop a market orientation. Above all, it would have to ensure that the fruits of its labour reached the 'market' in the 'real world', and would result in the creation of jobs and wealth and contribute to the national quality of life, or face disaster. Such a transformation would require extensive homework, ruthless self-evaluation and meticulous planning.

The starting point to effect change centred around the extent of the adjustments required for the CSIR to perform its allotted task of technology transfer to industry. The original intent of Government with the Kleu investigation was to achieve improved use of the country's available production factors; to increase competitiveness through increased productivity, both locally and overseas; to increase profitability, new manufacturing opportunities and job creation. The CSIR's plan of action would have to include short- and long-term components, which could result in major and costly changes for the organisation. Government agreed to make funds available to bring about the required adjustments.

The pivotal role in achieving this ideal was that of Clark who was specifically charged with getting the initiative off the ground. The Council had given him one year to show convincing results, and he took up the challenge with everything he had. During the first few months he visited every institute and listened to both scientists and management's views. He read volumes on technology transfer as practised in other parts of the world. Finally he convened a task group to review all aspects of the technology transfer policy.[2]

Clark was the first to assemble such a task group from leading thinkers in the organisation with the aim of devoting themselves exclusively to defining the CSIR's business. It took the form of a *bosberaad* to provide the required seclusion. Clark supplied the members with appropriate literature to focus their thinking and the interactive experience that followed proved to be highly productive. The group distilled their insights into a simple diagram, depicting a user of technology and a provider of technology, to describe the future function of the CSIR. They came to the conclusion that, as a technology provider, the CSIR, in its current form, would not be able to cope successfully with its newly allocated responsibility. This task group approach became the preferred mechanism for problem solving during the transformation process that was about to take place.

Garbers, by nature an analyst, approached the imminent organisational transformation with characteristic circumspection. An encounter that helped to shape his approach was the example set by the President of the Max Planck Institute in Germany, Reimar Lüst, who had decreed that for every new institute created an existing one had to be closed. This approach forced people to analyse very carefully the relevance and viability of existing research areas as well as those under consideration. This philosophy sensitised Garbers to look critically at activities that were being kept alive at the CSIR, while new ones were being added, ostensibly in line with its mission.

A significant influence on the change architects' approach was a method applied by the Arthur D Little Group in the USA, namely the task group approach, that had been so successfully applied by Clark's technology transfer group. According to this method, a task group is assembled for a given purpose with powers to co-opt whoever might be appropriate to achieve the goal. At various stages the composition of the task group is revised and adapted to deal with the next phase should this prove to require a different combination of skills. Once the task was accomplished, the group is dissolved. This approach proved to be one of the decisive factors in the successful conclusion of the CSIR's restructuring. It replaced the old system of appointing committees for fixed periods whose ability to act seemed to suffer from terminal bureaucratic paralysis.

The Executive consulted widely, with the CSIR Council and senior staff members, with major stakeholders, including industry, government departments, universities and private individuals. The task groups were drawn from key staff who worked on clearly defined aspects of the restructuring process, studying specific problems, topics or opportunities, and made recommendations. The direct consultation of its top people generated a great deal of enthusiasm for the change among those involved.

The task groups' activities were run in tandem with those of the consultants who were tasked to do audits and ask incisive questions about present operations. The consultants focused on management and business structures and aspects of marketing. The decision to use both local and overseas management consultants played an important role in introducing strategic management into the CSIR. They were utilised as a mechanism to gain specialist input, to keep CSIR managers honest and to ensure objectivity.

On the consultants' advice, the Executive wore light or brightly coloured, informal clothing when leading working sessions in order to create the right atmosphere and to soften the negative component of the change message. The informal appearance would also suggest a desire for action and signal a break from the traditional formality of the past. The informal tone was further underlined by addressing everyone involved by their first name and playing down academic titles. As Garbers's wardrobe consisted mostly of sober formal clothing, he actually had to buy casual shoes and expand his range of leisure wear!

The logical point of departure was to revisit the original brief of the CSIR as defined in the relevant Acts of Parliament[3], and to take a critical look at the development of the function of science councils in South Africa. Their designated function was research and development, which was defined as the systematic execution of creative investigative work in order to increase knowledge which is used to devise new applications. The councils are held responsible to Parliament to justify the execution of their mandate; they have no limits imposed on the fields they serve and interact with both public and private sectors, with the social, economic and science and technology spheres of the community, and know no territorial boundaries. These activities should by rights be protected by law and not be controlled.

The CSIR had developed several mechanisms over the years to carry out its various appointed tasks. The analysis identified four current functional components: Research and development; management of selected national research facilities; national research funding; and patenting and licensing.

From the late 1970s the Executive had made some successful, if sporadic, attempts to rationalise the activities of the CSIR. Budget cutbacks by Government had focused attention on privatisation to relieve the financial burden. By the time the CSIR was planning its proposed transformation, it had already transferred to commercial concerns the printed circuit unit, the responsibility for training instrument makers and some technical services activities. Rationalisation had resulted in reducing the number of personnel

from an all-time high of nearly 5 600 to about 4 900 by 1986 spread (fairly thickly) over 22 separate institutes, laboratories or groups and five service departments.

With the recommendations of the technology transfer task group and professional consultants to guide them, management set about its task. A change management team, consisting of members of the Executive and task groups made up of senior management, analysed the situation with the thoroughness bred by years of meticulous research work, and developed an excellent grasp of the realities facing the CSIR. In broad terms, the team would have to come up with mechanisms to redirect the organisation to shift its focus to technological applications of much greater relevance to local industrial and community needs, to contribute an increasingly bigger percentage of its own income through contracts with the private sector, and to play a far more active role in supplying expertise to and in supporting science and technology-related activities in Africa.

At this stage in 1986 the organisation was constituted as illustrated on page 55.

COUNCIL OF WAR

Forty years of research experience, covering a wide range of fields, in many of which international recognition had been achieved, constituted an immense national asset. Even its critics conceded that the CSIR had accumulated a high percentage of the best scientists, engineers, technicians and administrative support staff in the country. As a national research facility it had also built up a wealth of excellent research equipment and facilities.

Over the previous two decades, selected groups within the CSIR such as the materials research, integrated circuit, optical manufacturing units and some of the sector-oriented institutes had experienced increased contact with the business world, prompted by specialised demands such as commercial ceramics, electronics, defence and infrastructural needs. The demands of delivering viable commercial products of good quality, within budget and on time added a new dimension to their research training. Their pioneering efforts held within them the seeds of the CSIR's future. Ideas were being tested and new mechanisms explored. Thus when the time for change arrived, people were available within the organisation to lead the change, and they could select proven practices to be cloned.

Their exposure to modern business practice alerted them to the flaws in their own internal management system. The additional limitations imposed by the bureaucratic system frustrated go-ahead managers, who wanted to meet the new challenge presented by current market forces, and they

CSIR STRUCTURE 1986

COUNCIL

PRESIDENT

VICE-PRESIDENTS

RESEARCH INSTITUTES/FACILITIES

Sector-oriented Research Institutes
Applied Chemistry Unit
National Building Research Institute
National Food Research Institute
National Institute for Aeronautics and Systems Technology
National Institute for Coal Research
National Institute for Materials Research
National Institute for Telecommunications Research
National Research Institute for Oceanology
National Timber Research Institute
National Institute for Transport and Road Research
National Institute for Water Research
South African Wool and Textile Research Institute

Discipline-oriented Research Institutes
National Research Institute for Mathematical Sciences
Laboratory for Molecular Cell Biology
National Chemical Research Laboratory
National Physical Research Laboratory

Profession-oriented Research Institutes
Chemical Engineering Research Group
National Institute for Mechanical Engineering
National Electrical Engineering Research Institute
(The above research institutes were supported by relevant regional laboratories in Bellville, Cape Town, Bloemfontein, Durban and Johannesburg)

National Research Facilities
Hermanus Magnetic Observatory
National Accelerator Centre *(which included the former Southern Universities Nuclear Institute)*
Radio Astronomy Observatory
Satellite Remote Sensing Centre
South African Astronomical Observatory

Industrial Research Institutes
(jointly financed by industrial sector)
Fishing Industry Research Institute
Leather Industries Research Institute
Sugar Milling Research Institute

OTHER

Service Departments/Institutes
Administrative Service Department
Information and Research Services
(including scientific liaison offices in London, Paris, Bonn, Washington and Los Angeles)
National Institute for Informatics
Estates Services Department
Technical Services Department

South African Inventions Development Corporation
(a statutory body resorting under the CSIR by an Act of Parliament)

FOUNDATION FOR RESEARCH DEVELOPMENT

COMPOSITION OF EMPLOYEES	
Management	103
Researchers	1006
Scientists	411
Technicians	1322
Administrative staff	816
Support staff	1271

made their voices heard. Ironically, these scientists were the very people who were being penalised, as contractual constraints prevented them from producing the academic publications required to advance their careers in the old dispensation.

More conservative elements, who wanted to maintain the status quo of the intellectually exacting but sheltered ivory tower approach to science, strongly resisted any involvement with the dirty world of utilitarian science and even the euphemistic 'directed science'. They felt they were being strangled to death by the inadequate funds available to do 'real' research and the increasing pressure to contribute more to earning their keep. Among them were some of the best scientists in the country.

Retaining this enormous asset posed one of the biggest challenges to management. If they could not convince these scientists of the necessity to channel their skills to goal-directed basic research, it would be a severe loss to the organisation.

In order to harness the immense potential of the CSIR to contribute to the country's development, certain features needed to be built into the genes of the organisation to create a new culture. A unified mission was needed as well as clearly defined goals, objectives and strategies. With the many fundamentally different roles the CSIR played (research, funding, management of national facilities), this was hardly possible. The current situation did not promote interaction between institutes, leading rather to a duplication of research work and facilities, exacerbated by extreme competition between individuals and institutes.

The most difficult adjustment would be to develop a business orientation. Previously the economic impact of the excellent research contribution was hardly considered, nor was active marketing of its services. In fact, any institute earning more than 30% of its income through contracts was seen as deviating from the CSIR's true function and duly chastened.

Very often brilliant concepts were transformed into products for the commercial market, only to discover that there was no demand for them. Potentially successful products often suffered because mechanisms for technology transfer existed only in selected areas, leaving the implementation to the sponsor, if any. Because virtually no skills existed in-house for the proper industrialisation and commercialisation of viable commercial products, many of these potential money spinners were not fully exploited.

A management culture needed to be established. Confusion existed about 'Council functions' and 'CSIR functions', both bodies being referred to as councils. Inside the CSIR the entire management composition consisted of academics and good researchers who were expected to become man-

aging administrators and project managers overnight. In many cases this amounted to a double loss. Not only were their research talents virtually lost to the organisation, but their lack of managerial skills could even prove counterproductive.

As management was the only form of real promotion, very few scientists refused the job. Many were thoroughly miserable in executing duties for which they had neither the training nor the inclination. Before eventually accepting their fate, new 'managers', aching to pursue their true vocation, could be heard to express their frustration with 'spending an entire day without having anything to show for it'.

The extensively used advisory committees, drawn from universities, government departments and industry to contribute to research direction, proved ineffective probably for lack of true responsibility and accountability.

READING THE ENVIRONMENT

The CSIR's resolve to change was further strengthened by public criticism of the way it conducted its business. The late Professor Louis van Biljon, for example, submitted a controversial article to the press early in 1986, a copy of which was given to the CSIR.[4] The article referred to the national research funding system managed by the CSIR. Van Biljon claimed that universities were far more productive with the funds they received than was the CSIR. Thus he questioned government's choice of the CSIR as the prime instrument for technology transfer.

Using the electronics activity of the two organisations as an example, Van Biljon compared the number of technical staff involved, the income earned and the output, based on the published information available. He also questioned the group's choice of research direction and claimed that research and development in general belonged at the universities. This refrain was taken up by the then Deputy Minister of Trade and Industry, Dr Theo Alant, who criticised the CSIR in Parliament for not being concerned enough with practical issues.

The CSIR reacted by immediately referring the matter to an independent authoritative body to investigate the allegations made by Van Biljon, and it was agreed to withhold his article from publication pending the outcome. Professor Christo Viljoen (University of Stellenbosch), Mr Fred Bell (the then head of Armscor) and Mr P Meerholz (Barlows) under the chairmanship of Dr Charles Boyce (Deputy Director-General of the Post Office) were invited to serve on the task group.[5] They found that Van Biljon's figures to prove the difference in productivity were based on incomplete information and that the electronics group had indeed made responsible research

choices. However, in view of the CSIR's responsibility for technology transfer as advocated in the White Paper, they advised the group to be more proactive, to keep closer contact with industry and to shift the emphasis from scientific research to industrial research. The committee also recommended that it would be better if an independent body were to allocate research funds to dispel the existing perceptions, not because the function had been abused.

Although these findings did vindicate the CSIR's position to a large extent, they also served to confirm the Executive's decision to address the very real problems confronting the CSIR, particularly concerning the relevance of its work to industrial and community needs. The recommendation on research funding strengthened the CSIR's view that FRD should eventually become an independent body.

Against the backdrop of the cold war between the West and the Soviet Union, the fact that South Africa was an important source of much of the Western world's essential raw materials had created an artificial sense of economic security locally. In reality, the country had suffered a decline in international status and had become increasingly isolated following the government's disastrous pursuit of the apartheid policy and departure from the Commonwealth. Sanctions were becoming increasingly effective and the economy was being steadily eroded. The black liberation struggle was rapidly gaining ground, and the political aspirations of the disenfranchised majority were being expressed in no uncertain terms.

The international campaign to isolate South Africa impacted severely on the free exchange of scientific knowledge. South African scientists tried their utmost to maintain international contact, with limited success. In the long run isolation took its toll, and access to the international scientific community was more and more confined to high-level personal contact between individuals. The truth is that they were fighting a losing battle because the Government's policies were morally indefensible – policies, moreover, which directly affected research direction, resulting in part of the CSIR's activities being devoted to the development of technology to strengthen the hand of the security forces.

On the other hand, some of these developments held temporary benefits for science and especially technology in South Africa. A successful local armaments industry was built up. The embargoes on military imports created a market for local research, design and development over a wide range of technologies, both for armaments and import replacement. The science councils and universities benefited, not so much by the amount of money provided by the Government, but by the opportunity to find a local market for their scientific capabilities and the job opportunities created in the field.

International trends in science and technology policy added further pressure towards change. Increased efforts were being made to harness the benefits and achievements of science. Export drives based on technology-intensive products had started to dominate the international marketplace. The trend clearly pointed to an increased emphasis on industrial research, for which market orientation, business and management skills were essential.

On the local front the manufacturing industry was struggling to increase its productivity. The country had been trying to develop its secondary industry for nearly 60 years. By 1986 the manufacturing industry was contributing about 23% of the gross domestic product (GDP), but its share was not increasing.

Proportionately it contributed less to the balance of payments and to job creation than the primary sector. In its role as a source of industrial research, the CSIR had a responsibility to address this problem, both in providing technological support and in influencing the technology policy of government.

If the CSIR was going to transform itself, it would need to be far more flexible, and therefore more autonomous, to respond to the demands of the rapidly changing environment. The system of framework autonomy recently devised by the Commission for Administration in response to the CSIR's efforts promised to provide a greater degree of autonomy. Its implementation implied that an independent board of directors would be appointed to look after the affairs of the CSIR. This was a momentous step in the CSIR's move to revolutionise the organisation, as the Board's leadership played a decisive role in shaping the events to follow.

Framework autonomy was subsequently extended to other statutory bodies as well. Government's adjustment of its science and technology policy included deregulation of statutory science councils, with funding being calculated according to the baseline approach. The Scientific Priorities Committee had been scrapped and in future the CSIR would have to compete for the available research funds in the public sector. Government at the same time promised that these funds would be increased, a prediction that unfortunately did not materialise.

The reduced budget contribution from state central funding would force the CSIR to increase its income from contract research. This in turn would serve to discourage unproductive activities and involve end users in determining future research and development priorities. An independent board was essential in these circumstances.

Although not perfect, framework autonomy represented a big improvement on the previous system. The system still imposes restrictions on the remuneration process, made worse by its prescription of unrealistic em-

ployee categories, each with a prescribed maximum salary average determined by 'equivalent' civil service salary scales; by determining the pensionable component of management's salaries; by prescribing the number of cars in the overall car scheme, without any consideration of the nature of the business and needs of the organisation. But it is more flexible in that the CSIR no longer needs approval for how it manages its remuneration packages within the constraints of the prescribed maximum average and affordability.

Although the system freed the research councils from much of the restrictive civil service practices, it failed to provide a strategic framework of national priorities. In the process of allocating resources, the organisation, with the Board's guidance, was left to set its own priorities. These decisions, however excellent, were made in the absence of an encompassing national strategic framework.

D-DAY

Finally, the outcome of this extensive soul searching exercise was integrated and evaluated. The Executive summarised the findings in a document entitled *Strategy for the Future Course of the CSIR*, which was ratified by Council with enthusiasm, and issued in October 1986. Top management had taken the historic decision to change the course of the CSIR.

Since the Rustenburg meeting the previous year, it was clear that some form of change was in the air, and widespread speculation on the form it would take had been rife among the highly inventive staff. The flames were fanned ever higher by snippets of information gleaned from the task groups involved in the assessment process.

In an effort to minimise the rumours and also to humanise the effect of the printed report, Garbers decided to communicate the gist of its contents personally to the workforce before making the document public. All members on the main site were invited to congregate on a grassy knoll opposite the executive building for the occasion. Garbers proceeded to outline the steps to be taken and the arguments that led to the revolutionary decision. In the aftermath, this gathering promptly came to be referred to as 'the Sermon on the Mount'.

Carefully selected task groups worked on an action plan to implement the strategy. They investigated options for an appropriate marketing, financial and personnel policy, the best way to handle the national facilities, support services, administration in general, the South African scientific liaison offices and industrial research institutes. Management's first reaction to adjust to a reduced income and to entrust the responsibility for technology transfer to a foundation was long discarded. The reform machinery was in

the process of formulating a far more radical solution.

After the basic strategy for the new CSIR had been drafted, selected consultants and Vice-Presidents Clark and Dr Neville van Deventer went on a world tour to visit similar research organisations that had already gone through a process of adapting to the changing research scene, before deciding on a final structure for the organisation.

The university-style structure based on disciplines and professions had to be transformed into a carefully co-ordinated structure of strategic business units according to the market they served. The broad spectrum of activities attended to in the past were scrutinised and the bona fide capabilities identified. Armed with this information, the organisation was restructured to match the country's projected market needs within the constraints of these capabilities. The Executive, in collaboration with the consultants, integrated all these painstaking deliberations and findings of top management, senior staff and the consultants into draft recommendations, which included the proposed new structure of the CSIR and amendments to the Scientific Research Council Act. The draft plan was submitted to the management group in February 1987 at the second Rustenburg summit, after which the final draft was submitted to the Council for approval. The reaction of the chief directors was mixed. Those committed to own-choice research found the proposals far too radical, while others welcomed the opportunity to create a whole new organisation that would be in tune with current realities.

The Flying Samoosas 6

Full fathom five thy father lies:
Of his bones are coral made:
Those are pearls that were his eyes:
Nothing of him that doth fade
But doth suffer a sea-change
Into something rich and strange.

Shakespeare – *The Tempest*

IN THE DRY DOCKS

The shift in emphasis to develop a major focus on implementation was a foregone conclusion. The means to achieve this end would require major surgery, not only in altering the management style and structure of the organisation, but in rationalising the content of its work and the composition of its staff. The so-called skills match would see many excellent workers at a loose end and make passengers uneasy. The culture change from a semi-civil service type of environment to a market-oriented, streamlined, brisk business concern would be a difficult and traumatic process.

The technology transfer task group had already hinted at major structural changes to meet the multiple challenges facing the CSIR. The impressions gained during the study tour had strengthened the resolve to steer clear of cosmetic surgery. A radical solution had been drafted in broad terms and, following current management practice, the team formulated a vision for the organisation's long-term direction and spelled out a detailed mission statement,[1] complete with long- and short-term goals, strategic approach and management philosophy.

The strategy differed radically from that of the old CSIR. To make up for the steadily decreasing state funding and to respond to the demand for increased relevance in its choice of research, the task group had decided to transform the CSIR into a contract research organisation. Its strategy in-

cluded marketing the CSIR as a professional service; determining market needs and responding realistically to these needs; increasing its focus on the output of the research process and the transfer of technology; focusing on management as a priority; providing training to enable staff to fulfil the new mission and bringing their remuneration packages in line with market-related standards.

These resolutions required the organisation to be virtually rebuilt from scratch. The entire staff complement, including top management, was temporarily suspended and its organisational structure dissolved.

Central to the success of the operation was the adoption of a CSIR specific organisational model. The work done by JL Porras at Stanford University in the USA on processes relating to organisational change provided much insight.[2] His research had shown that changing the structure would have little effect if the behaviour of individuals did not change accordingly.

An enormous effort went into drawing up a customised model and planning the steps required to achieve its successful conclusion. Among them would be changing the Act of Parliament governing the CSIR, drastically amending the funding mechanism, introducing a flat management structure, replacing all management systems, altering the conditions of service – the list goes on.

Many of the organisations visited during the study tour had opted for a more conservative approach in adapting to the changing environment by creating a marketing department to handle the commercial function, while keeping technical staff away from clients. The task group was convinced that this approach had not been successful. They believed clients would want to make sure at first hand that when investing in research they were investing in a competent professional. They were therefore adamant that researchers should personally get into the marketplace.

It was realised at the time that flexibility was important, as future adjustments to the new structure would be called for to address changing circumstances and also to be able to react swiftly should any part of it prove to be off the mark.

Initially, in 1987, the broad structure consisted of four groups: Research, Development and Implementation (RDI), consisting of 11 priority market areas headed by Dr Brian Clark; Foundation for Research Development (FRD), Dr Reinhard Arndt; Corporate Financial Management, Albert Michau (April 1988) and Corporate Support Services, Dr Neville van Deventer. Garbers remained as Executive President of the organisation. As professional financial management was crucial for guiding the CSIR into becoming a market-oriented organisation, great pains were taken to find a suitable candidate to head the activity. After months of head-hunting,

CSIR STRUCTURE 1988

COUNCIL

PRESIDENT

VICE-PRESIDENTS

CORPORATE FINANCIAL MANAGEMENT	RESEARCH, DEVELOPMENT AND IMPLEMENTATION GROUP		FOUNDATION FOR RESEARCH DEVELOPMENT	CORPORATE SUPPORT SERVICES GROUP
Financial and Commercial Planning,	Aeronautical Systems Technology	Microelectronics and Communications Technology	Research Support Programmes	Communication Services
Management and Control	Building Technology	Processing and Chemical Manufacturing Technology	National Research Programmes	Advanced Computing and Decision Support
	Earth, Marine and Atmospheric Science and Technology	Production Technology	International Scientific Liaison	Human Resources Development
	Energy Technology	Roads and Transport Technology	National Research Facilities: Hartebeesthoek Radio Astronomy Observatory	Information Services
	Food Science and Technology	Water Technology	SA Astronomical Observatory	Overseas Offices
	Materials Science and Technology		National Accelerator Centre	Technical and Site Services

Mr Albert Michau was appointed in April 1988.

As critical was the appointment of a new top management team to head the restructured organisation. While the policy was to retain as many of existing staff as humanly possible without jeopardising the new mission, the positions of divisional directors and centre heads were thrown wide open. Once appointed the directors would be responsible for assembling, from the available pool, the technological activities and staff appropriate to their division's market area.

Eventually most of the staff were 'reappointed' to appropriate positions in the restructured organisation with some redundancies of technical and administrative staff whose areas of expertise did not survive the ration-

alisation. The previously centralised administrative bureaucracy was decentralised almost completely to operating divisions, resulting in substantial staff redundancies in this area. Such staff were retained for a period during which they assisted with general administration associated with the restructuring process. They were given first option when vacancies occurred and were sponsored to go on training courses if required for the position.

Every effort was made to ensure that those members of staff who could not be accommodated in the new structure were afforded a fair and equitable severance. This highly sensitive operation understandably did not run without a hitch. Some senior staff members who were not happy with either the alternative positions or the severance packages offered to them took legal action against the CSIR, but eventually mutually acceptable arrangements were made.

The management hierarchy had become considerably flatter, resulting in a reduced executive complement and shorter communication lines. It consisted of the Council (now called the Board), the Executive, Group Management, Division/Centre Management, Line and Staff Management.

The workload of the Executive was ruthlessly purged of operational micro-management functions, changing fundamentally to that of policy consideration, decision-making and co-ordination between the four groups. The importance of strong financial management was emphasised by elevating the function to group executive level. Human resource and marketing management followed the same route at a later stage.

To underline the radical change of direction and the introduction of an entirely new culture, the CSIR's logo was changed and a new corporate identity established. The old logo was associated with the gateway to knowledge and was based on the A-frame arch that marks the entrance to the CSIR's northernmost gateway.

The new logo is made up of four equilateral triangles resembling four delta-wing aircraft flying in formation – soon to be dubbed the 'flying samoosas'. The solid triangle symbolises the contribution of the three basic sciences, physics, chemistry and mathematics, to the activities of the CSIR, while 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.

As can be expected, the very human reaction to resist change was unleashed among many of the employees: the triangles were pointing in the wrong direction, the design was too 'busy', the symbolism contrived,

There was also a deeply entrenched loyalty to and pride in the old logo behind the resistance. Outside the CSIR the reaction was less emotional and in general favourable. Time brought acceptance, and the 'samoosas' are now referred to with a kind of humorous affection and pride, while the old logo seems somehow old-fashioned. It has a distinct association with red tape and yellowing reports gathering dust in the archives – not without a touch of nostalgia, though, for the 'good old days'.

ON THE BRIDGE

The top management team was put through a particularly stringent selection process to ensure it had the required personal and leadership qualities. Of the 14 members appointed about half had been chief directors previously, two were outside appointees and the rest came from other management structures within the CSIR. They were:

Dr Johann Fritz	*Aeronautical Systems Technology*
Mr Roy Page-Shipp	*Building Technology*
Dr Jan van Zijl	*Earth, Marine and Atmospheric Science and Technology*
Mr Dieter Krueger	*Energy Technology*
Dr Piet Steyn	*Food Science and Technology*
Dr Geoff Garrett	*Materials Science and Technology*
Mr Johann Ahlers	*Microelectronics and Communications Technology*
Dr Tony Pizzi	*Processing and Chemical Manufacturing Technology*
Dr Maurice McDowell	*Production Technology*
Dr Charles Freeme	*Roads and Transport Technology*
Dr Daan Toerien	*Water Technology*
Dr Duncan Martin	*Centre for Advanced Computing and Decision Support*
Dr Ben Fouché	*Centre for Information Services*
Mr Patrice Laserre	*Technical and Site Services*

They reported for duty on 1 August 1987 as 'cadets' to undergo a rigorous training programme. The success of the transformation effort would largely depend on their ability to drive the change process and lead the new initiatives. They had to be familiarised with the philosophy behind the decision to opt for a revolutionary change in direction, with the importance of and mechanisms to effect a culture change, with management science and business practices. The challenge was a daunting but exciting one. Thanks to Clark's dynamic leadership and his enthusiasm for this mo-

mentous task, the team was infused with the will and energy to smash the organisation through the barriers of tradition, natural resistance to change and paralysis created by the shock of the revolutionary extent of the decision.

Teamwork was the key to the success of the changeover. The top management team operated at levels well above their previous best performance. The team felt empowered. The vision was clear. Clark knew what he wanted and his thorough preparation enabled the team to throw out the rule book. The situation created its own set of rules, namely the commitment and loyalty to the vision.

The team consisted of a number of widely divergent personalities that made for a healthy balance. Their commitment to the ultimate objective served as the binding factor in the process of becoming an efficient team, cemented by a shared sense of fun which helped to maintain the momentum of the change process.

The volatile Dr Tony Pizzi, an Italian by birth and director of the chemical processing activity, was held up by the team as a mental hit man. Jokes about the Mafia and associated mayhem abounded. During one of their sessions someone asked for a pen, and to the hilarity of his colleagues, Pizzi, with a Latin flourish, produced a pen from his pocket marked . . . Rentokil!

Conflict among the team members during planning sessions was considered healthy. It showed that members were not simply accommodating each other, but were prepared to defend their viewpoints. The team that emerged was extremely motivated and keen to get the new initiatives off the ground. Their commitment was a decisive factor during this extremely difficult phase when new initiatives were being implemented and old practices phased out.

The members of the team who took part in this phase still regard it as one of the most exciting times of their lives, and also the most gruelling. Accepting responsibility for changing an organisation the size and importance of the CSIR was enormous. They realised they had the opportunity of a lifetime to do something of lasting importance.

At times the goal to be achieved seemed almost impossible. The consequences of failure would be immense, virtually career-threatening. There was no guaranteed recipe or road map to follow.

Some lay awake at night, while others simply never allowed themselves to entertain the thought of failure. Those with doubts and fears were sustained by the team. Garbers accepted doubt as a necessary component of faith and used it to question the validity, but never the inevitability, of events from time to time. Clark, personally, had the feeling of conducting

a holy war and was among those who would not consider the possibility of failure. They became a team with true shared responsibility.

The enormity of the challenge created the most stimulating environment imaginable for people to operate in. They were stretched to perform to the utmost of their ability, their pioneering efforts only to be compared with those of their predecessors who founded the CSIR four decades previously. They emerged from the planning phase in a state that bordered on euphoria. As Dieter Krueger put it, they felt like supermen who were going to change the world. Such concentrated zeal could not continue indefinitely.

Every single member made a significant contribution, including those who opted out later in the process. Directors in fact helped to create the very environment into which they themselves would no longer fit. As the CSIR progressed along its chosen course, some of the directors, who were either excellent researchers or analysts, discovered that they did not really take to the market-oriented culture or management scene and chose to return to their area of expertise. They were replaced with directors with different profiles, according to what the CSIR management had learned from experience was required.

While the RDI Group management team was out planning for the future, another team was holding the fort, carrying on with the business of the day. These staff members played a vital role in the success of the transition. Many of them did so with the full knowledge that there was no room for them in a similar management capacity, or even in the organisation, in the future. The integrity of these people deserves the highest praise – they were the unsung heroes of the transition.

The hallmark of the new leadership style was the principle of empowerment. In contrast with the past when heads of institutes had very limited autonomy, the new leaders had to accept full responsibility for their strategic business units. Garbers's self-discipline was severely tested when he chose to remain aloof from the meeting during which the redistribution of the CSIR's resources among the newly formed divisions was being decided. Even such extremely important planning procedures were left to the chosen team. They had to take responsibility for the dogfight that ensued and sort it out.

Clark had acquired much management insight over the years of managing research contracts. While the group and its projects were small, the hands-on approach worked. But when the volume of work increased, a course in project management made him realise there was a different way of doing things, a line of action that could be entirely contrary to one's natural inclination. His workload left him no choice but to practise what he had learnt. The result in many cases was observing the remarkable

growth in young researchers who were entrusted with the increased responsibility. It was a double gain because it reduced the burden of the manager and held the benefit of grooming a talented young person to handle management responsibility successfully. This approach was one of the basic tenets of the new management culture.

Those leaders who had suffered the frustrations that confronted a chief director in the old dispensation took to the new management style with enthusiasm. While they had the benefit of a thorough knowledge of the organisation, the other leaders, who came from outside or lower down, had the advantage of carrying no baggage. Where divisions were created from bits and pieces of the old structure, the premises positively hummed with creative energy. Their members learned and matured at a faster rate than the divisions which virtually retained a former structure, with the exception of those groups who had in fact pioneered the new direction. Much also depended on the individual director, whether he used the opportunity to the best advantage. In the initial stages the rate of change varied considerably from division to division.

Strong leadership is crucial to effect change. Using position power or leading by cold reason alone may achieve the desired results, but to inspire anyone, the conviction must come from the gut. Garbers's commitment to the change process, which entailed the complete overthrowing of the organisation, took immense courage. His natural analytical ability, his unceasing attention to detail, his sensitivity to the environment and his wide learning enabled him to develop a global perspective. The key to his resolve was his conviction that 'no problem can withstand the assault of sustained thinking'.

His abilities were complemented by the driving force of Clark, whose conviction bordered on, if not exceeded, the zealous in implementing the change. His vision, of transforming the CSIR into an organisation of far more relevance to industry, was born from first-hand experience in the CSIR. He had benefited from its advantages as well as experienced the frustrations of its failings. Having risen from the ranks to his current position and enriched by extensive exposure to a whole range of international research organisations, he was convinced that the chosen path was the right one. Clark's understanding of the role of strategic management in a technological environment was vital to the sustained success of the change. The Board had made no mistake in singling him out to drive the change process.

The RDI Group, as the business component of the CSIR, had as yet no in-house marketing skills, and appointed a marketing manager to the group to introduce professional marketing functions. Directors had autonomous control over the operation of their divisions within the constraints

of the group policy, which they had helped formulate in the first place. The director's responsibilities included market analysis, the development of a strategic plan and budget, determining the appropriate structure and deployment of staff to fulfil the division's function. In the new culture, these functions were carried out in consultation with key staff members.

Each division was to be organised into programmes which could accommodate projects of varying life span and scope. The next step was to define highly specific outputs from the various research and development projects. The management technique appropriate to these multidisciplinary programmes would require elements of matrix management to be incorporated.

Both programmes and projects had to reflect market needs and be subjected to regular and rigorous evaluation. The dynamic nature of the new approach ruled that projects should be promptly expanded or terminated in line with market dynamics. Commercial activities had to be properly balanced by the maintenance and extension of a multidisciplinary knowledge base, organised into well-motivated fundamental or directed research projects. Both contracts and government-funded capacity-building initiatives would be managed as projects, placing the emphasis squarely on project planning, budgeting and management.

The director selected key thinkers and leaders from the resources under his jurisdiction to determine the division's strategy and structure. This group, amounting on average to about 20 members per division, included his already appointed personal assistant, financial and human resources managers, in most cases a marketing representative, and technical staff representing a cross-section of the technological expertise within his market area. With consultants acting as facilitators, this group went through a well-structured process to decide on a market-related programme-based structure, decision support being provided by the latest computer software to narrow down the choice in as objective a manner as possible.

From this group the director selected his management team, who were then put through a phased training process to prepare them for their new leadership roles. Courses included marketing basics, to be followed later by advanced marketing courses, courses in negotiation skills, basic financial skills, situational leadership and project management – in fact, all the ammunition the business school arsenal could provide.

To kick-start this radically different process required a radically different management style. Appropriate leadership was needed to lead the organisation through the disruptive period that lay ahead and to sustain the change process. The choice was unhesitatingly the implementation of participative management within the framework of challenging perfor-

mance targets with shared responsibility teams to achieve the targets. The team approach was a vital component of the ultimate success of the initiative.

Each divisional management team had to develop and inspire a new team spirit, including new loyalties and skills to launch and cement the new participative management style of the CSIR. Managers had to take responsibility for actively developing their staff's skills, to act as facilitators and coaches to help subordinates get the job done. The Executive with the divisional directors would devise the overall corporate strategy, after which each division would enter the planning phase and draw up a detailed plan of action in line with the overall strategy. In addition they had to contribute to developing the organisation as a whole and accept joint responsibility for the overall excellence of the organisation.

This approach created high levels of involvement and distributed decision-making power to all levels of the organisation, while maintaining a balance between authority and autonomy. In this way tough challenges could be set, not by means of rules and regulations, but through the nature of the job itself. Staff had the freedom to use whatever mechanisms they chose to reach the goals, following which firm performance control measurement systems were introduced to evaluate and reward the achievement as objectively as possible. Not only did this participative approach result in a strong sense of ownership and commitment, but it created much greater respect for management as a discipline.

With the strategy, structure and reallocation of staff complete, the relocation of the new units had to be tackled. An architectural consultant was brought in to assist with the logistics. Ideally, each employee should have experienced a physical relocation to reinforce the change message. The cost of moving expensive and highly sophisticated facilities, however, dictated a more pragmatic approach and determined to a large extent where units were accommodated.

METAMORPHOSIS

The deadline for the implementation of the new structure was set for 1 April 1988. By then the middle management teams had been selected, and each division had to complete overhead cost analyses and a repeat in-depth marketing study. On 1 April when the new CSIR was officially constituted, all the divisions were up and running. The official launch was a festive occasion held on the soccer field, complete with marquees, banners, balloons, an ox braai and a cast of thousands. The banners displayed the divisions' names and official code colours. Mementoes were handed out bearing the slogan: 'We're changing for the better.' Many members, who were

used to the low-key academic atmosphere of the old CSIR, felt uncomfortable with the ra-ra carnival style launch recommended by consultants and considered it not in keeping with the dignity of a serious research organisation. However, nobody failed to get the message that the organisation had irrevocably broken with the past and was entering a dynamic new era.

In April 1988 the new Scientific Research Council Act[3] was passed. Henceforth the CSIR would be known by its acronym CSIR/WNNR only, a message that has not been fully absorbed outside the CSIR to this day. The new Act strengthened the CSIR's ability to exploit new technology, and finally the separation of the offices of chairman and chief executive was official. Dr Louw Alberts became the first independent Chairman of the revamped CSIR Board in June of that year.

The Board now had the independence it lacked previously and it was empowered to fulfil its original function much more effectively, that is, acting as a high-level communication channel between the CSIR and decision-makers about national and international scientific and industrial policy matters; approving proposals on strategic policy matters; and representing and promoting the CSIR's best interests. The change also meant that the Board was functioning along the lines of business principles and played a far more active role in determining the organisation's operation and future, including appointment of the president.

The new Board had additional powers, for example, the ability to decide on issues such as relationships with educational organisations, employee training and remuneration, purchase of property, borrowing and investment of funds, and exploitation of technological innovation.

The choice of Dr Louw Alberts as the first chairman of the new Board was based on his various appropriate associations. He had just retired as Director-General of Mineral and Energy Affairs; he had been the head of a parastatal organisation, namely Mintek[4], and had been professor of physics. He had a good knowledge of how government and the bureaucracy machinery operated, part of the function of the Board being to interface with government. He was also well known to Minister Danie Steyn who was responsible for the CSIR at the time.

The new Board assigned some of its members to focus on personnel matters and another group to attend to financial matters. The remuneration policy was a matter that warranted immediate attention. The uncompetitive nature of the salary structure was particularly vexing to highly qualified staff. If the organisation claimed to be market-oriented, it needed to pay market-related salaries. With framework autonomy now a reality, the details of its application had to be worked out.

The Board's financial task group consisted of top people from industry

and helped to set the scene for the growing awareness of business basics among the workforce. The task group insisted on getting financial reporting in line with business practice, adding another professional dimension to the organisation.

The presence of a chairman who had both government and industrial experience was fortuitous. He could act as a bridge between the viewpoints of industrialists and researchers. Although he understood the uncompromising commercial demands of the industrial world, he had enough academic genes left to know that creative people needed, as he put it, 'space for constructive havoc' so as not to lose their creativity. A policy could thus be formulated to ensure optimal return on investment within the framework of the research environment. The old *laissez-faire* management of financial affairs disappeared rapidly in the new dispensation.

The more professional business approach of the CSIR evident in recommendations to Government carried far more weight with the authorities. The independent Board had the muscle to disagree with Government and win. The high-profile organisations Board members represented could not be easily dismissed. Their independence gave the Board the teeth it needed, and with that their rubber stamp image was gone for good.

The Foundation for Research Development (FRD), established in 1984 to encompass the previous Research Grants Division and Co-operative Scientific Programmes, was at the time of the restructuring loosely linked within the CSIR. Its mission in the new organisational structure was to support research, research application and research training within the engineering sciences and the applied and basic natural sciences. It also accepted responsibility for the national secretariat of the International Council of Scientific Unions (ICSU), and from 1988 for the national facilities – the National Accelerator Centre (NAC), the South African Astronomical Observatory (SAAO) and the Radio Astronomy Observatory (RAO). The building of its new headquarters started in the same year. The Magnetic Observatory at Hermanus and the South African science and technology liaison offices also resorted under FRD until its independence. Following a periodic reassessment of the CSIR's functions, both bodies were transferred to the RDI Group.

A critical appraisal of the status and role of the FRD at the time of the restructuring highlighted the areas where changes could be effected. As in the rest of the CSIR, the emphasis on research of national importance could be increased, as could the monitoring of return on investment. In view of the country's limited research human resources, the importance of collaboration among participating scientists was re-emphasised.

The evaluation system was found to be excellent, as was the responsi-

ble allocation of grants. Since the introduction of the new system, there had been a substantial increase in all types of research output and the recognition of excellent performance had created a positive research climate. However, despite South Africa's strong intellectual tradition, its isolation exacted a heavy price, firstly, in the low percentage of published papers in international scientific journals[5] and, secondly, in not adhering to the trend to increase the emphasis sufficiently on relevance in research topics.

The appropriateness of the CSIR's role, as a market-driven organisation, in the management of funding research outside the CSIR and awarding uncommitted postgraduate bursaries was questioned. The CSIR was playing two roles that differed radically from each other. The role of investing in university research was to develop scientific human resources to the benefit of the country, while the other role was to develop and exploit knowledge for commercial application and gain. Management considered the culture of these two functions to differ significantly, and provision was made for Parliament to transfer the responsibility of the FRD to an independent body in future.

Shortly after he assumed office, Garbers had ordered members to reform the Employees' Association. Their first attempts were so involved that it practically killed social life within the organisation. Arndt and Clark were given the job of sorting the matter out. The result was the establishment of an open social club in 1988, the CSIR Staff Association, which merged the functions, not the bodies, of the previous Employees' Association and the all-white Lucanos Club, while the accumulated assets of the latter would henceforth be administered by a sub-club, called the CSIR Holiday Club. The Staff Association deals with amenities and social activities and is not a bargaining unit for organising benefits. By now all amenities were open, and all official and social functions had been desegregated.

Since the early 1950s the CSIR had been steadily registering patents, and in 1962 the South African Inventions Development Corporation (Saidcor) had been set up as a statutory body under the CSIR by an Act of Parliament[6] to undertake patenting, licensing and the development of inventions. By 1985 the corporation's investments of venture funds in industry amounted to R15 million, of which 45% was generated internally from its royalty earnings, the balance being derived from long-term state loans.

To accommodate the new CSIR's expected investment in innovative technologies, the country's largest venture capital company, Technifin, was set up in collaboration with the Industrial Development Corporation. The CSIR was allocated 50% of the shares held by Saidcor and made a R25 million contribution to its initial capital using income from a previous successful licensing agreement. Saidcor became a shell company whose remaining

income from royalties is managed by a board of trustees.

Having defined its true function as being a provider of technology, the CSIR realised that a number of its past activities did not fit into its new mission and would be done more effectively if privatised. Three of its previous support activities were promptly privatised. The training function was taken over under a management services contract with a private consulting group, later to be named the Groman Consulting Group. The idea was to retain access to the latest technology in human resource development, collect royalties on the sale of CSIR training modules, while shedding the responsibility of maintaining an in-house training team.

The management of the CSIR's motor vehicle fleet and transport services was contracted out to Avis Rent-a-Car, and the design and drawing offices were taken over by Destek Designs. Other support activities followed the same route at a later stage, such as graphic arts, photographic services, the production kitchen, and more recently the cleaning services. (The latter is a particularly gratifying development as the cleaning staff decided to form their own small enterprise, Thuša, and continued to provide a service under contract to the CSIR for personal financial gain, retaining most of the previous cleaning staff.)

The progression of change followed an interesting pattern. The various broad phases were spelled out to the staff with appropriate target dates. The closer to a crucial decision it moved the more intense the criticism became. But the moment the action had been implemented, the general reaction was that it should have happened long ago.

With the initial planning phase completed, the ship was ready to leave the dry docks and test its mettle in the real world. It now remained to be seen if the crew and new-look ship could maintain its course and reach its destination.

Getting Shipshape

7

No profit grows where is no pleasure ta'en;
In brief, sir, study what you most affect.

Shakespeare – *The Taming of the Shrew*

THE TAMING OF THE CREW

It was a period of intense personal growth for those who had been appointed to the new management positions. The new era was characterised by strategy sessions with professional external consultants, training courses to acquire appropriate skills, and above all the sense of shouldering real responsibility according to the new empowerment policy. A sense of excitement took hold of this select group who were eager to meet the challenge. The enthusiasm spread to those associates who could identify with the new philosophy. But resistance was evident where the fit of skills or inclination was at variance with the new direction, or where the new initiatives had not been properly communicated to the next level of responsibility. Despite copious precautions, and given the financial and human constraints, mistakes were bound to occur – some would prove to be fairly costly.

All staff members attended a basic market orientation or customer care course to start them off on acquiring marketing and business know-how. Visual reinforcement through entertaining videos made Tom Peters, Edward de Bono and John Cleese household names. Gradually trainees gained familiarity with the concepts and associated jargon: the four Ps (or was that six according to the latest business guru?), SWOT analyses, cash cows, dogs, cost-benefit analyses, profit margins, cash flow and, especially, ROI (return on investment).

The decision to involve its technical staff in direct contact with clients was severely criticised at the time, but experience proved that it was important for researchers to get out of the laboratory to make personal contact with potential clients. The exposure served to confirm the importance of research relevance and accelerated acceptance of the new direction.

Business skills were sharpened among those so inclined, some opting to go the whole hog and leave the CSIR to join the private sector, while others of a more scholarly bent became increasingly frustrated and sought the familiar pastures of the university – by now a paler shade of green as government cutbacks were affecting the scope of university research as well.

But it was not all plain sailing for those who took on the real world. Attendance at business courses was not enough to protect trusting researchers from burning their fingers and in some cases getting severely mauled. Only experience would preserve the naïve would-be entrepreneur from entering into contracts that tied the CSIR into legal knots or costly renegotiations.

Unfamiliarity with the new approach also led to overreaction as some staff immediately went about billing an unsuspecting telephone caller seeking advice on a technological problem. Of course the old CSIR did err in being extremely free with advice that was probably based on years of research and worth millions to the client. Both the researcher and the client were in for a period of adjustment and education. In fact, the very terms 'client' or 'customer' were a new concept for the CSIR. It would take considerable time for its members to become comfortable with the commercial approach to science and to absorb the message of 'the customer is king'.

However, under pressure to adhere to the new mission, some would-be entrepreneurs started promoting their own services in their zeal or anxiety to reach the marketplace. Though well-intended, the erratic and uncoordinated nature of these none too professional 'advertisements' confused potential clients and also gave out the dangerous message that the CSIR could be all things to all men. The Executive had successfully launched an official promotion campaign to create public awareness of the CSIR's new initiatives, but had not foreseen this individual resourcefulness.

In all truth the new CSIR did initially try to be active on too many fronts. It would take time for even the leaders to get used to defining projects, not according to the expertise in hand, but rather to market dictates. Even to this day, management guru Peter Drucker's message of 'focus, focus and focus' needs periodic reinforcement. Scientists tend to be super-analytical and intensely critical. They are forever redesigning systems, products, processes – you name it – to achieve the ultimate result, which is the

bane of the innovator or perfectionist. As the influence and demands of the commercial world became ever more evident, those in charge of developing products were forced to discipline themselves to deliver what was promised 'on brief, on budget and on time'. Economic reality and year-end financial results are great allies in this respect.

The support structure of divisions largely mirrored that of corporate. Each had a financial and human resource manager, while most of the units had a so-called marketing manager, whose job description varied from division to division. Gone were the days of bureaucratic administrators. The culture of service to your internal customer was part of the market orientation. The bulk of the support staff absorbed the message fairly rapidly. Others had to be 'persuaded' by enthusiastic programme managers who insisted on efficiency and good service. Yet others lingered on . . .

The initial enthusiasm was severely tried by the realities of increased responsibility as members advanced along 'the learning curve', in terms of the current jargon. Miracles were expected of programme managers who had to fulfil the functions of marketer, administrator, project and technology manager, financial and human resources whiz kid – later diagnosed by the Executive, the system's instigator, as the Captain Marvel syndrome. Not to mention the poor 'marketing manager', who was usually a thinly retreaded communications expert with editing and publishing skills or an extrovert researcher with maybe an MBA, and who was now expected by virtue of his or her title to bring in the business.

With the retrenchment spectre ever present, these were indeed trying times for all those involved in retraining programmes. Researchers, who had previously occupied high managerial positions on the strength of their good research record and had not been appointed as programme managers, suffered a great deal of stress. Others again had to adapt to a new research field or face retrenchment. The dual career path, proposed to give excellent researchers the same status associated with management positions, was not yet fully developed. However, de-emphasising status was a deliberate strategy to entrench the changeover to a flat management structure. Stress-related complaints increased dramatically at both the medical and human resources counselling centres.

With the replacement of the old Personnel Administration System by that of framework autonomy, a new remuneration system had to be developed. To reinforce the business culture, a whole range of new systems and practices was introduced. The latest trends and systems, particularly those applied in the private sector, were studied, resulting in a new personnel policy and revised conditions of service, including phasing in reduced leave privileges. Staff were strongly encouraged to accept the new system, but

could choose to remain with the old one which held certain advantages in the short term. It was clearly in the interest of all but those on the verge of retirement to accept. (At present six employees out of a total of about 3 000 still adhere to the old system and enjoy marginally better leave privileges, but are bound by civil service salary increments which have long been surpassed by the CSIR's ability to bestow financial rewards.)

Job evaluation and classification systems, appropriate career paths, performance evaluation based on key result areas and remuneration systems were scrutinised and selected to match the new business-oriented approach of the CSIR. In time the job classification system selected was replaced with one more suited to the CSIR, namely the Hay system, provoking much initial criticism for adding a further disruption in already turbulent times.

A rent system was introduced to finance the section in charge of managing the CSIR's estate. The divisions now had to pay rent per square metre for the space their activities occupied. This step had dramatic consequences. It was quite remarkable how previous demands for more room could shrink to perfectly rational levels!

The message to become business-oriented was conveyed with much vigour and reached down to every level of the organisation. Even the Chairman of the Board, Dr Louw Alberts, confident of the legitimacy of his request, was charged by the well-trained clerk supervising the photocopier for the enlargement of a diagram he needed for a Board meeting.

These teething troubles faded into insignificance in the face of the enthusiastic acceptance of the new CSIR by its old customers, who welcomed their transformed business partner who now talked their language, were prepared to listen to their problems and were developing a sense of urgency that was lacking in its previous response pattern. New customers were attracted by the CSIR's willingness to deal with practical problems and welcomed the surprising scope of the technological resource available to them.

The emphasis on teamwork was not confined to the top management team, but became one of the hallmarks of the new order. One of its manifestations was in the task group approach mentioned previously. These teams got on with the business, cracked the problem in hand and were then dissolved.

Thus appropriately selected task groups would spend say two days of intense concentration on their allotted task and bring out a report, which, if not accepted, was scrapped and the team sent back to the drawing board. If the recommendations were accepted, the task group could implement anything immediately. In the old system a new suggestion could

take up to a year to be digested by the organisation, let alone for action to follow. Now, if a policy or swift action was needed, the decision could be made, the action implemented and tried out, within a week if necessary.

This dynamic process is not necessarily healthy or efficient under all circumstances, but during a major change the pace of implementation cannot be allowed to lag. The empowerment of the task groups to take swift action added to the momentum that kept the change process going, irrespective of the fact that it led to making mistakes.

After the enormous job of initiating the change phase, the implementation phase introduced challenges of a different kind. The level of excitement produced by the planning phase was mostly sustained as the positive results of the implementation initiatives started taking shape. Management teams thrived on the experience of running the transformed organisation successfully – they felt energised, moved faster and revelled in their achievement. But the challenge could also be extremely stressful.

Initially for some, the mundane business of daily housekeeping was something of an anticlimax. They missed the excitement of being part of a team that was breaking new ground and creating mechanisms to revolutionise the organisation. They mourned the loss of the fast pace and focused thinking of the task group and resented being bogged down by the nitty-gritty of 'making it work'. To switch from a mode of being able to ignore the routine interruptions in a manager's life, while being involved in the important strategic intervention part, to the more pedestrian style of the implementation mode was a bit of a letdown. This feeling of frustration often gave rise among this group to projecting the situation experienced at the time as negative.

AGAINST THE TIDE

Changing the organisational culture to incorporate a market orientation demanded a drastic adjustment. Staff had to develop a sensitivity to client needs, time constraints and results, and a commercial awareness of revenue and costs. Fully aware that cultural change was a complex and painful process, management carefully phased it in over the next few years.

To realise the new vision required the introduction of a new value system, being one of the core elements of an overall corporate culture. Staff had to realign their behaviour to the new way of doing things. Since behaviour is driven by individual personal values, the new value system had to be understood and accepted to become personal, or there would be no change in behaviour.

Researchers had to learn a whole new approach to research. In the

past the assumption was that wealth could be converted into knowledge with the government's blessing and the taxpayers' money. Research projects were mostly selected on an ad hoc basis, often following the inclination or hunch of individual scientists with little regard for the needs of stakeholders or end users. Over the next few years, the gradual realisation of the current economic and political realities, and exposure to international research management trends, brought acceptance and appreciation by most hardliners of the applied multidisciplinary approach.

The introduction of ad hoc task groups as an operational instrument emphasised action and promoted a sense of urgency demanded by the new culture. Not only did this system enhance decision making, but the broader involvement of staff helped to increase familiarity with and commitment to the new culture.

Culture change deals with the beliefs of people, not necessarily with facts and truths. It involves the way employees behave towards their clients and towards each other, including seemingly trivial things like telephone behaviour and personal appearance. Technical experts had to make the transition to serving the client's needs and not telling him what they thought he needed, or at least be subtle about it. Support staff, used to waving the rule book, had to realise that their fellow employees deserved the same VIP treatment as an outside client.

For staff to adhere to a new value system, goals and objectives had to be clearly defined. They needed to understand and accept the new structures within which they were functioning. To ensure the success and progress of such a drastic culture change, good communication was all important as was the reinforcement of positive behaviour, dealing with insecurity and stress, resolving conflicts without delay and supplying appropriate training.

While those selected to new management positions were motivated to accept the change in direction, most of the workforce went through a very traumatic phase in the process of aligning themselves to the new philosophy. Much management energy was required to counter the moves made by people actively opposed to the change. For those who were convinced that the mission of the CSIR was based on knowledge for its own sake, the transition was virtually impossible. For those who had become accustomed to the bureaucratic culture with its minutely defined structures and systems guiding their work behaviour, with the many rules that remove the responsibility of making difficult choices, the climate became increasingly threatening.

As the effect of the new initiatives became apparent, staff began to realise the extent to which their lives would be disrupted. It was least felt by

those scientists who had mostly practised applied research and now had to adjust their approach to include market and client awareness. But many of those more involved with fundamental research described their reaction as close to nausea. Fundamental research projects that had been painstakingly built up over many years had to be abandoned because the return on investment was out of all proportion to their cost. Scientists who had been steeped in the classic tradition reacted in anger and dismay. This reaction was intensified by the disappearance of the words physics, chemistry and mathematics from the divisions' names, which seemed to be symbolic of the demise of the three basic disciplines in the new dispensation. Support staff who knew that the streamlining of an organisation usually impacted first on them, were thrown into turmoil and became almost paralysed by the uncertainty of their future.

Management had made the painful choice to follow a proven recipe to effect change. The process was driven from the top, and the first step was to 'unfreeze' the status quo (later to 'refreeze' when the change had been irreversibly established). Firstly, the retrenchment of seven senior office bearers[1] made the change process visible and brought home the magnitude of the situation. Secondly, maintaining an atmosphere of uncertainty was a deliberate strategic move, supported by a campaign of equating the previous CSIR approach with the era that dinosaurs ruled the earth. A culture change video, starting with the primeval cry of a dinosaur, to introduce Clark's expounding on the evils of the past and the necessity to 'adapt or die', caused much alienation, but left the audience in no doubt that management meant business. The sheltered employment culture of the past had to be shocked out of existence.

These drastic actions were taken with the unanimous approval of the Council, which was fated to play such a decisive role in shaping the future of the CSIR. To this day its members refer to the experience with pain. It was terrible to take decisions that would result in hurting respected members of the top management cadre. The emotion can be likened to that of a good general who knows he is sending his troops into a war where many of them will fall. He cannot show emotion or appear hesitant in the face of a battle for survival. He must live with the knowledge that he has probably sacrificed some of his closest and best associates.

The restructuring was a particularly disturbing experience for those members of the Council who represented universities or research organisations. They recognised that change was necessary, but found it hard to come to terms with the radical degree it assumed. As Professor Wally Prozesky put it,[2] their heads agreed but their hearts regretted that it should be so. Thus, there was no real opposition to the restructuring initiative, but members

who supported the traditional approach to research did express certain reservations. They saw a potential danger in the drastic transformation, in that the volume and quality of basic research might decline in the country and that the CSIR might in time run out of its own manpower. The CSIR would no longer be grooming young researchers to do basic research to the extent it once did, and would have to purchase its manpower in competition with industry.

However, the globalisation of business and the demands being made on research were changing, the emphasis shifting increasingly to a multidisciplinary approach to provide competitive advantage, including skills other than the purely scientific. Council members who represented industry did not share the misgivings of their academic colleagues. Their management experience proved invaluable in guiding the CSIR through the transition and they welcomed the more practical approach.

There was, however, no getting away from the unhappiness caused by these seemingly insensitive moves at the time. To have well-known and respected figures declared redundant was a severe shock. Those staff who fell victim to the proposed new system and were declared redundant underwent the worst kind of trauma. They had to come to terms with the fact that despite their acknowledged good track record and loyalty to the CSIR, there was no place for them in the organisation in its new guise – a transformation to which they, in some cases, did not even fully subscribe. Families were thrown into turmoil and needed to be reassured that their breadwinners had done nothing wrong.

One or two controversial appointments from outside the CSIR to strengthen its business arm fanned the fires of revolt even higher, especially if these people disappeared from the system after a short while. In the turmoil an impression developed of decisions being taken without proper deliberation and implemented with indecent haste, almost impulsively. This was the negative side of the dynamic task group approach.

Naturally loyalty to the organisation took a severe knock and any declared policy of caring for its staff was met with cynicism. Much of the antagonism was directed at the change merchants personally. Clark, more than anyone else, was singled out as the protagonist. This view was later reflected in the press by describing him as the hatchet man employed to do the dirty work associated with the restructuring. Acting in good faith and deeply convinced of the correctness and absolute necessity of the initiative, this view caused him much pain. The negative publicity also affected his family.

It was even more distressing as management believed they were doing it according to the book and acted with the required decisiveness. Clark,

in particular, had made a thorough study of handling change in large organisations and management had taken every precaution to approach the process in as sensitive a manner as possible. The operation couldn't be dragged out or it would have been worse, and the managers themselves constantly warned that there was no guarantee against making mistakes. Despite their considerable efforts at increasing communication in the organisation, they probably erred in not communicating the well-founded reasons for their actions clearly or widely enough.

Many employees who left the CSIR during this stage and did not experience the subsequent benefits of the new era could logically harbour negative and resentful feelings towards the organisation, or rather towards the people who were tasked to implement the radical initiatives. Fortunately we live in modern times or the bearers of the 'bad' news might well have been slain as the custom was many centuries ago. Today the reaction is less barbarous, being limited rather to character assassination, the effect of which eventually evaporates as hindsight and distance provide perspective.

Managing the different reactions to the transformation process proved to be more complex than anyone had foreseen. There were those who put everything they had into planning the change but came to realise that they did not fit into the new environment and left; those who were retrenched through no fault on their part because of the change; and those who thought they could adjust but were unable to do so. Everyone of them contributed to the multi-layered tapestry that was being woven and the immense learning experience, and deserves credit for the role he or she played.

Thus, for the change managers, there was nothing else to do but to bite the bullet, go quietly grey and accept that change was hardly possible without casualties. In fact, there were remarkably few considering the magnitude of the culture shift that was being implemented.

The emphasis during the restructuring was on getting the right line people in place. Failure here meant there would simply be no business to support. In the drive to follow modern business management practices, top appointments were made on preselected premises of potential alone without regard for seniority or even experience necessarily. This was a courageous and progressive step prompted by the need to ensure that the new management teams would have the appropriate personal attributes to implement the new initiatives and philosophy. So much depended on the quality of their leadership.

In some cases people who were relatively speaking juniors were appointed over the heads of their previous bosses. The drawback was that these

senior people had, conventionally speaking, every right to expect to be appointed. For them it must have been an exceedingly painful experience to attend a public announcement of their demise and to adapt to their altered status.

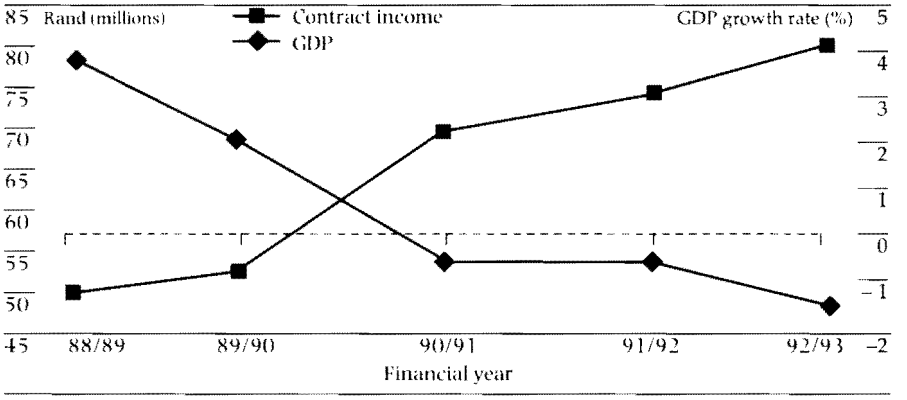
It is generally accepted that older people are less inclined to adapt to a new situation. The team appointed to lead the new CSIR was consequently relatively young (average 40 years), ranging in age from 31 to 52 years, a good mix of experience and youth. Some staff members, close to retirement at the time of the restructuring, chose early retirement. They were usually replaced by young graduates. The motive for this was twofold. On the one hand the practice did introduce new blood into the organisation; on the other, their lower salaries helped to reduce the gap between the actual and maximum average (the latter determined by the Commission for Administration) in the line function category, enabling the CSIR to improve salaries higher up in that particular category. All these factors reinforced the perception that experience no longer counted for anything, that management preferred to appoint two young scientists relatively cheaply in the place of one seasoned researcher.

To the staff in general, it seemed they had truly entered the jungle of the commercial world, the hire-and-fire mode of the private sector. The law of the business jungle dictated that you either had to get on to the bus or face being trampled in the process. In truth, the CSIR tended to pay more for retrenchment packages and probably tolerated more non-performance than its peers in the private sector.

It is to the change management's credit that they had the courage to give so many employees the opportunity to grow into new responsibilities. The humane face of the organisation was particularly evident in its appointment of in-house support staff who did not always have the required professional qualifications their new responsibilities demanded. Some performances exceeded expectations, while others did not progress so fast. The progress of the entire change process was probably retarded by this move, but on balance it was the humane thing to do. The organisation did survive, in fact prospered, even in the face of adverse economic conditions (*see* graph overleaf).

On the debit side, the decision to risk using underqualified support staff was probably made easier by the scientist or engineer's underestimation of the professional skills required to do jobs other than technological ones. In part, the undervaluing of the 'soft sciences' may have been an overreaction resulting from the technical staff's extreme irritation with the bureaucracy imposed on them in the past by the administrative support function. Cynics go even further by interpreting these appointments as an

'Counter trend' of CSIR's contract income (constant 1992 Rands) from the private sector compared with the state of the South African economy



attempt by line managers to control the 'puppets' in charge of the support function. Whatever the reason, there is no substitute for competence in the long run.

The modern practice of *bosberaad* also created a stir. Although the top management teams benefited greatly from the isolation to speed up the necessary planning procedure and the bonding effect that created efficient teams, the populace had little sympathy with this foreign practice. They conjured up visions of dark and secret dealings, sumptuous meals and money spent unnecessarily. The organisation was being dragged kicking and screaming into current management culture. In order to turn the ship around, the pendulum had to swing much further than usual to eventually settle in the adjusted equilibrium position.

With the salary structure far from market-related during the initial stages of the change process, and the loss of their subsidised benefits such as the bus service, such perceived misspending caused even greater turbulence. The perception of an elite group with special privileges increased the resentment against the change. In the harrowing transition stage when the benefits of the new system could not be implemented at an equal pace, staff felt that they had to display market-related behaviour without the associated market-related pay.

Apart from the bus service, changes were also effected in supplying subsidised meals, leave privileges were reduced in line with private sector practice, the Employees' Association was turned upside down, and the administration of the recreation site was streamlined. All of these were attempts to put the CSIR on a more businesslike footing, but were perceived as the actions of an organisation that no longer cared for its people. The feeling persisted for some time as soon after the transition, the economic

climate became steadily worse and further rationalisation had to follow, which helped to strengthen this perception. The bitter pill could only be sweetened up to a point – the real world did not tolerate sheltered employment.

The sudden emphasis on financial management raised awareness of actual income and expenditure. Although most people welcomed this new dimension, it required quite a drastic cultural adjustment. Previously staff accepted that the Government paid their salaries even if they were performing indifferently. Now suddenly strict performance criteria and affordability came into effect. Staff attached to divisions that manage their affairs well or are fortunate enough to be in a relatively lucrative market are financially better off. The practice is meant to increase staff's motivation to be more productive, but even eight years down the track it still creates a great deal of tension.

Management's view is that profitability is an unequivocal measure of whether a project is viable. Decisions on the viability of activities follow a rigorous and thoroughly responsible screening process, both for sound business reasons and for accountability to Government when it involves state funds. As Dr Harry Booyens, one of the early converts to the new approach, put it: 'There is nothing as beautiful and serene to work with as straight business.'[3]

Profit in CSIR's terms simply means maintaining a positive margin. Any surplus earned is ploughed back into the organisation, for example, to buy capital equipment. Previously funds for this purpose were budgeted for as part of the Parliamentary grant.

The newly introduced salary system, performance evaluation and allocation of job levels, although excellent initiatives, were not applied homogeneously across the organisation. Each strategic business unit phased them in according to its own interpretation and needs within the constraints of its micro framework autonomy, with the inevitable result that discrepancies occurred. This was not a conscious misapplication of the system but due in some cases to inexperience and the uneven level of professionalism prevalent in the support function, and consciously in others because it suited their business to follow a particular practice.

In an effort to place its media campaign on a professional footing, the CSIR management selected private companies to design and run its campaign, seemingly ignoring in-house-staff, who resented the 'yuppies from Jo'burg'. The CSIR experienced the full blast of the colourful extrovert commercial culture of the advertising world, while the companies concerned had to deal with a unique high-tech culture that was very difficult to get to grips with. Nevertheless, the campaign successfully broadcast the mes-

sage that the CSIR was a reformed organisation. The first attempt at a slogan, namely 'The CSIR – Your Technology Crucible', however, fulfilled all the requirements of a lead balloon. This was soon replaced by 'Your Technology Partner' – a slogan that has prevailed as its inherent philosophy truly reflects the CSIR approach to its business.

The well-calculated decision to opt for radical change rather than implementing incremental changes had been spelled out in the most emphatic terms. The widespread response to the implementation of the new initiatives at the time was that the pendulum had swung too far away from the classic research pattern with the changeover to a market-driven organisation. However, a modest push would not have been taken seriously and the change effort would simply have collapsed. As it is a trademark of scientists to find holes in any rule, they would most certainly have found ingenious ways to redefine what they were doing and carry on as before. A big shove provided the jolt that would make the ship alter course against the strong current of resistance.

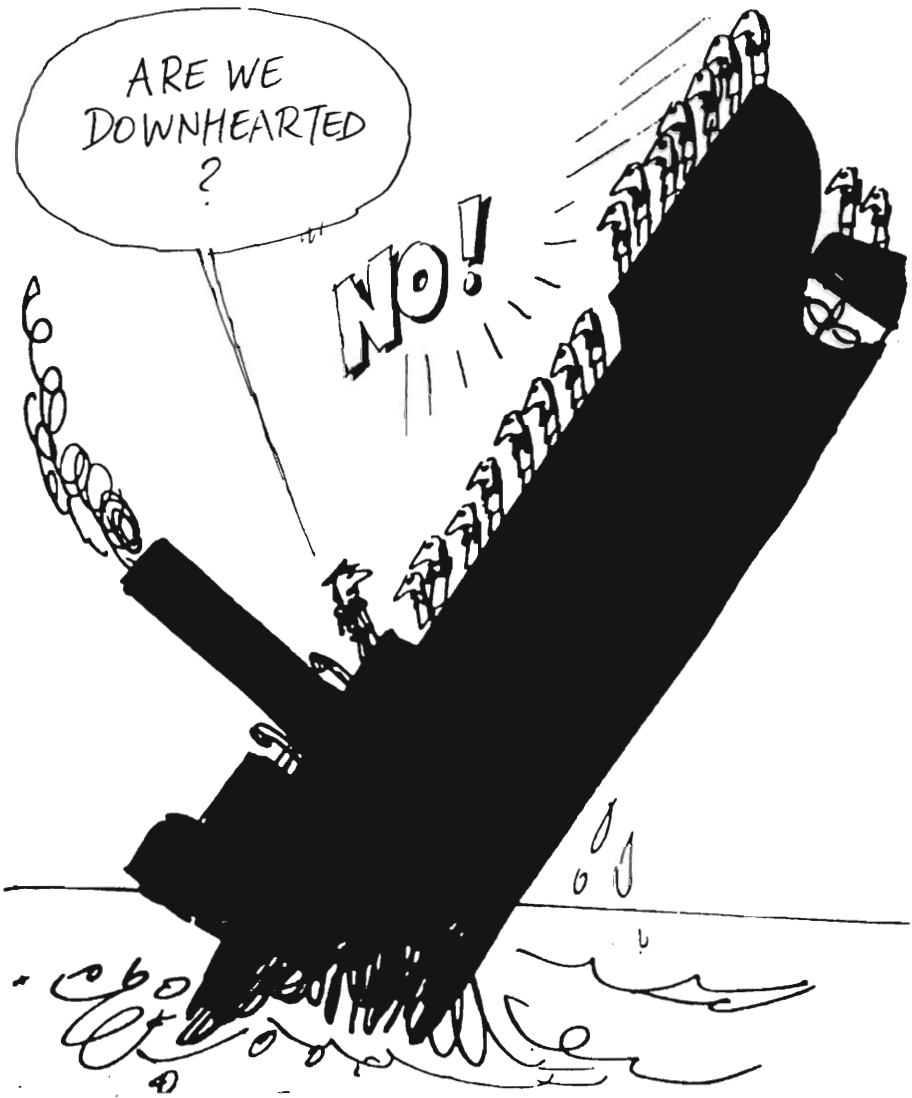
Attempts to circumvent the system became part of the initial adaptation process. For example, it was argued that if one produced a professional paper that was published to become part of the international scientific literature, those requesting reprints could be described as one's 'market'. People involved in editing technical documents started describing their function as 'packaging of the product' in an attempt to fit into the marketing mould and justify their function.

Some divisions enforced a philosophy that no project could be undertaken without industrial support. The staunch supporters of own-choice research pointed out that research judgement now seemed to be left to outsiders. This was an extreme view, but the radical shift of emphasis had to be driven home. Adjustments to this approach would follow once the culture had changed irreversibly. There was no avoiding getting people upset, and it probably increased the number of researchers who threw up their arms in disgust and left.

At the time the traumatic consequences dominated the minds of everyone affected, inside and even outside the CSIR. They reacted to what was interpreted as a drum beat for: 'Away with science!' Such perceived sacrilege prompted peers from outside the CSIR to taunt its representatives by referring to the organisation as the CIR, implying that Science had been abandoned. This incorrect perception still persists among those who have little contact with the CSIR.

Many employees expressed their criticism of this too radical shift, fearing that it was done without proper consideration of the consequences. The vigorous enforcement of the new philosophy was interpreted as aimed at

discouraging criticism. Following Tom Peters's joyous campaign for excellence, management practically demanded the admission that 'you were having fun' in applying the new formula. In response a cartoon, depicting a sinking ship, was circulated. The crew stood at attention on the deck of the severely listing ship and responded to the captain's question: 'Are we downhearted?' with a unanimous 'No'!



Cartoon circulated during the turbulent period when staff had to come to grips with a radically different culture. Enthusiastic supporters of the new system were seen as uncritical lackeys of the change management, while some initial dissenters held their peace, preferring to keep their heads down.

In the same vein, severe critics likened the situation to Solzhenitsyn's description in *The Inner Circle*, where citizens kept on applauding the announcement of unpopular decisions so as not to be seen to be the first to stop. Thus, those researchers who were convinced of the necessity of the transformation and assisted the Executive with enthusiasm were labelled as sell-outs and described as the Goebbels of the Fuehrer. Dire predictions were made that authoritarian style compulsory attendance of a gymnasium would follow.

Selected centres of excellence were kept going despite these noises and would later expand when the transformation was firmly established. Even here the research was focused on a particular topic such as superalloys, radar research, ceramic membranes, composite materials technology, and many more.

Gradually, as the arguments for and against were heard in the passageways and tea rooms, the mood shifted, and people accepted the inevitable and dealt with their feeling of uncertainty by making jokes. These ranged from lighthearted to downright vitriolic, the Garbers announcement being referred to as the Sermon on the Mount and the analogy of the sinking ship, for example. Events before 1986 being described as BC (before Clark) is another, in the wake of which snide remarks were made about Clark's attempting to walk on water. The unwillingness or inability to come to terms with the new situation was epitomised by an anonymous poem that was circulated:

They sent us all a letter
Saying: 'We're changing for the better'
Then proceeded to keep us in the dark.
They didn't seek our views
Nor give us any news
Just now and then an edict from the Clark.

. . .

Communication is so poor
That morale's dropped through the floor
And our questions lie unanswered, left and right.
Indecision seems to grip
The ones who steer our ship.
Do they know where we are going? Well, they might.

If they do, why not impart
That knowledge for a start

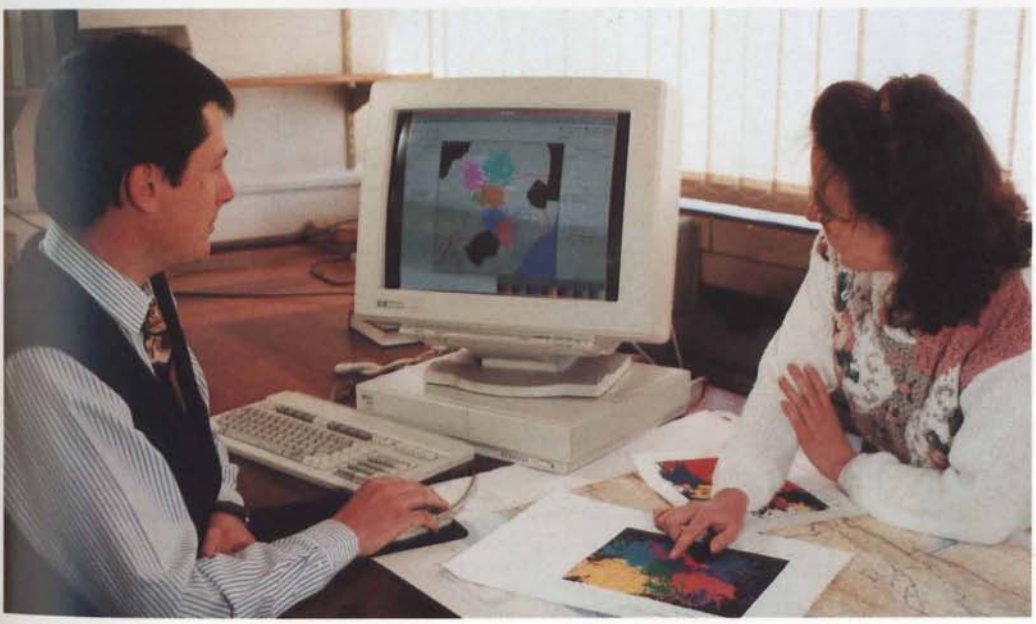
ACE, the CSIR-designed all carbon-fibre turboprop trainer aircraft, previously named *OVID*. *(Nic Papastefanou)*

The CSIR-developed carbon-fibre motorcycle wheel in action. The invention won an international Techtextil Innovation Prize in 1995 and is gaining acclaim on the race track. *(Nic Papastefanou)*

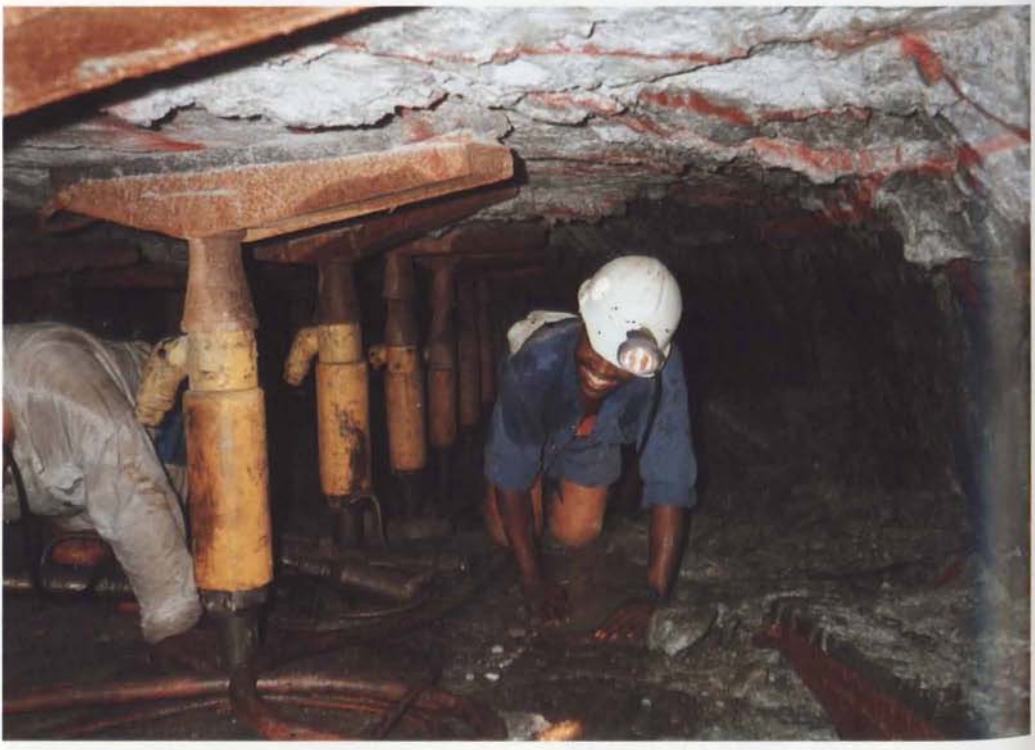
Fluidised bed combustion technology was developed for the burning of duff and discard coal, coal slurries, organic sludges and biomass waste. An associated hot gas generator and a boiler developed for different companies both received awards from South African professional engineering institutes.

Left: Supertag™, a revolutionary electronic marking system, is demonstrated at a supermarket. A trolley full of consumer goods marked with this radio equivalent of barcoding, can be read within seconds without unpacking.

Below: The CSIR collaborated with Armscor to plan an ultra-high-frequency radio communication system for the SA Police Services. Their efforts give SAPS coverage 99,9% of the time across 95% of the country. High quality reliable coverage was previously only available in the urban areas.

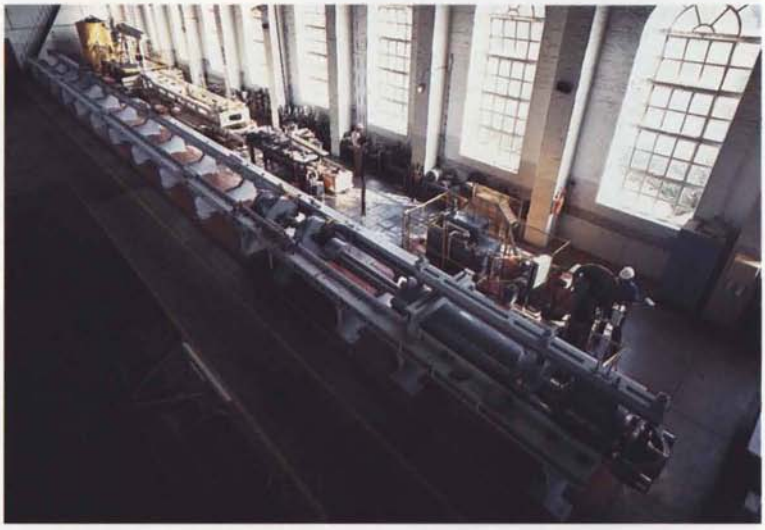


The Kloppersbos facility where research and development work is conducted on explosions associated with dust and mining.



Rapid-yielding hydraulic props which provide improved protection against rockfalls and rockbursts at the stope face in South Africa's numerous deep mines. This development is one of the many assets acquired by the CSIR via its merger with the Chamber of Mines Research Organisation.

Above: The heavy vehicle simulator simulates the effects of 20 years of traffic flow within three months, thus assisting with the improvement of construction, maintenance and the rehabilitation of roads. The CSIR has signed a contract with the California Department of Transportation for the supply of two of these South African-built machines as well as a five-year technology transfer project in California.

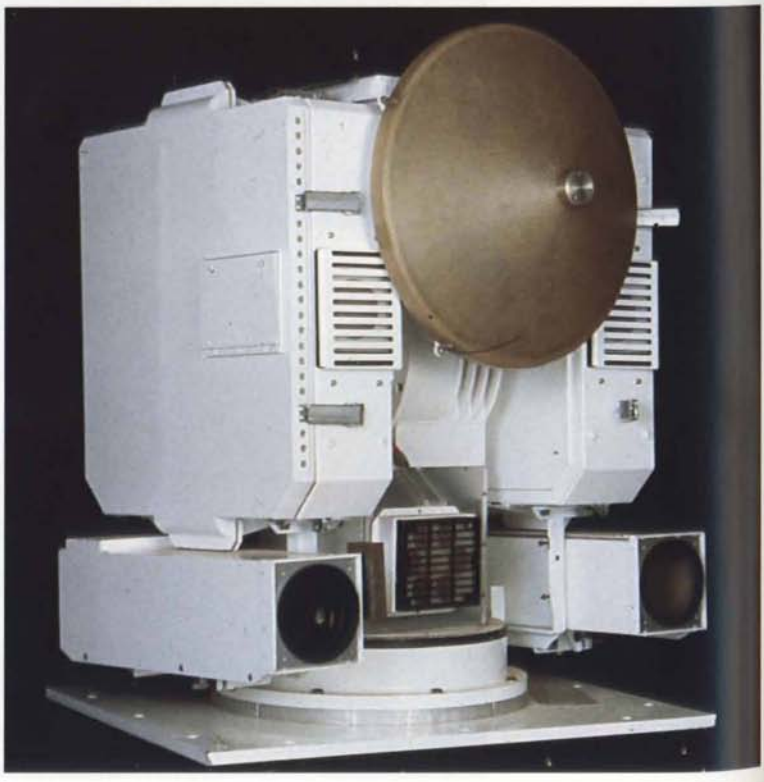


Centre: The CSIR's 100 MN tensile test machine used for statutory mine rope testing, provides a critical service to the mining industry to safeguard people and materials being transported in mine cages.

Bottom: SeamCam is an award-winning machine vision inspection system aimed at improving quality control.

Above: A Mirage F1 aircraft undergoing testing at the CSIR to determine structural dynamic characteristics. *(Nic Papastefanou)*

Right: The CSIR has developed an extremely sophisticated digital microwave radar which helps to make our skies safer for all and is now competing for international markets in radar applications.



Right: The old CSIR logo's and *(centre)* the new logo introduced in April 1988.

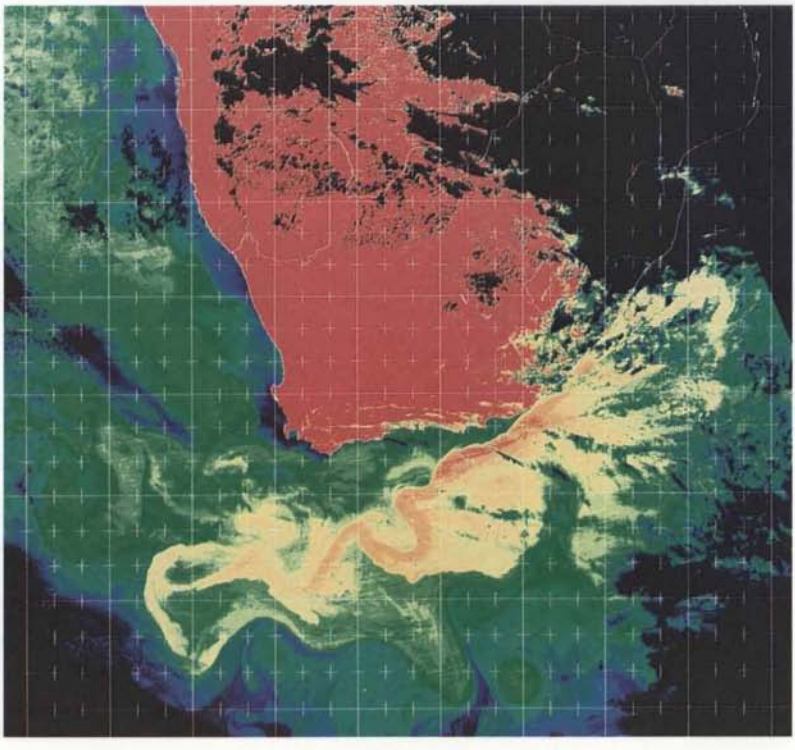
CSIR

WNNR · CSIR

CSIR

Top right: A space map of the area from Maputu to Lake St. Lucia produced by the CSIR's Satellite Applications Centre in 1995. The end result is presented in false colour where red represents vegetation and greenish-grey the lack of it.

Bottom right: A satellite image in which the ocean has been enhanced to show the warm Agulhas and cold Benguela ocean currents in 1992. The warm temperature current shows clearly as red, cooling to yellow, through green and ultimately dark blue.



Top: The CSIR has assisted Tyumbu Bricks near Umtata to improve the quality of their product. This project will result in job creation and expansion in order to be able to compete on the open market.

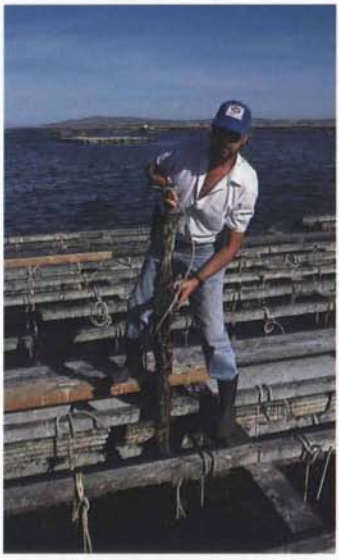
Centre left and right: The Boucell Raft Foundation System, suitable for problems such as collapsing sand or heaving clay. The system makes use of pre-cast concrete webs for support that can be manufactured on site.

Bottom: Years of experience in fire research resulted in a unique fire-protective coating for thatch. The difference between the untreated thatch on the left and the treated section on the right is clearly visible in this example.

Top left: Mr Nelson Mampuru of the CSIR demonstrates the small-scale production of atchar by means of the CSIR's atchar kit, which enables the self-employed small entrepreneur to produce a commercial product both scientifically and hygienically.

Top right: The CSIR provides technological support and project management in partnership with the Department of Water Affairs and Forestry to clear alien plants from catchment areas in order to enhance the availability of water. The RDP's six-man high altitude clearance team is seen in action here. *(Cape Times)*

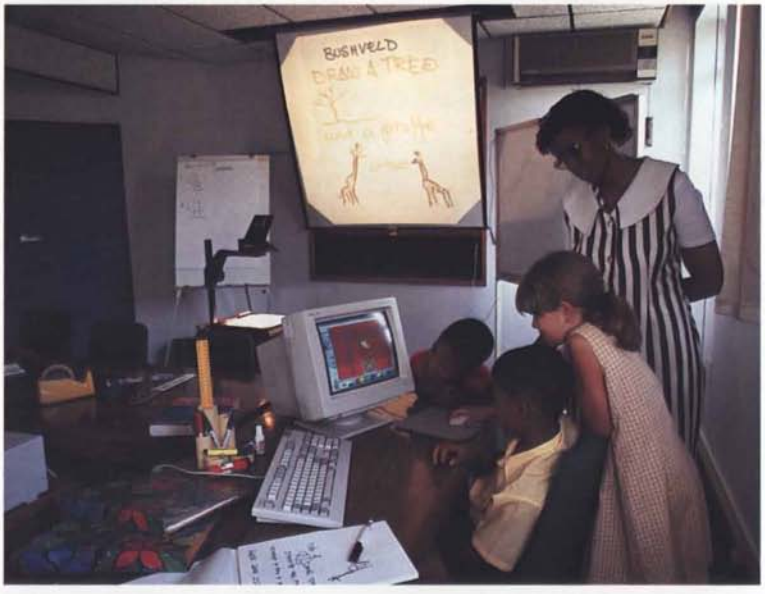
Above: An environmental study of the Great Brak River estuary showed that properly managed usage of the water available plus the addition of artificial mouth openings would counterbalance the negative effects of the proposed Wolwedans Dam constructed further upstream. The CSIR, along with the Department of Water Affairs and other interested bodies, was a member of the committee that conducted the study.



Above left and right: Netting for the cultivation of mussels is manufactured locally according to a process developed by the CSIR at the request of its client Sea Harvest.

Right and below: Inside the abalone hatchery at Hermanus, constructed according to the CSIR's design, a scientist inspects the progress of juveniles which will be harvested 30 months later for the commercial market. *(The Argus)*

A joint effort between community leaders, the CSIR's Port Elizabeth-based Division of Textile Technology, the Chamber of Industries, several large industries and training institutions led to the establishment of a Community Self-employment Centre (COMSEC), which has been accredited by the Department of Trade and Industry as a local business service centre. COMSEC is serving as a springboard for a number of textile-related small businesses such as weaving, upholstery and garment manufacturing.



Top: The CSIR is playing a leading role as a source of expertise in community-based information services in southern Africa. Current projects not only focus on addressing the welfare needs of the people, but cover all aspects of community life such as social and economic empowerment and recreational needs. Kiosks are being set up in readily accessible centres such as libraries and at tourist attractions to advertise local arts and crafts outlets.

Centre: The CSIR is a founder member of a distance education consortium, which includes government departments, NGOs and private sector companies, and provides support for the appropriate implementation of various technologies.

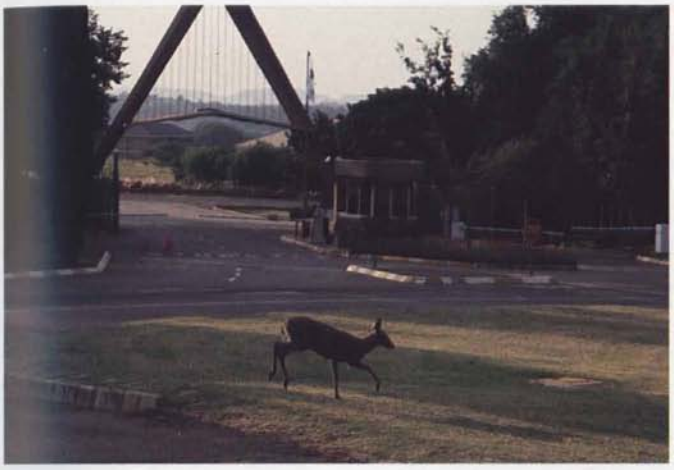
Bottom: As part of its Outreach Programme, the CSIR devised a competition to stimulate interest in science and technology in schools. The Mindwalk project drew entries from all over Gauteng where the first pilot competition was conducted. Here are some of the winners with CSIR Outreach Manager, Tsietsi Malehu (centre back), and President Geoff Garrett (far right).

The extensive grounds of the CSIR are home to an abundant assortment of indigenous wildlife and also house many recreational activities for the staff.

Left: Tarentaal – the popular pub for after hours socialising, named for the flocks of guinea fowl that have made the grounds their home.

Below left: Duiker and steenbok can be seen roaming the gardens in the early morning and late afternoon. *(Linton Davies)*

Below: The recreation area provides for a variety of leisure pursuits such as volleyball and swimming.



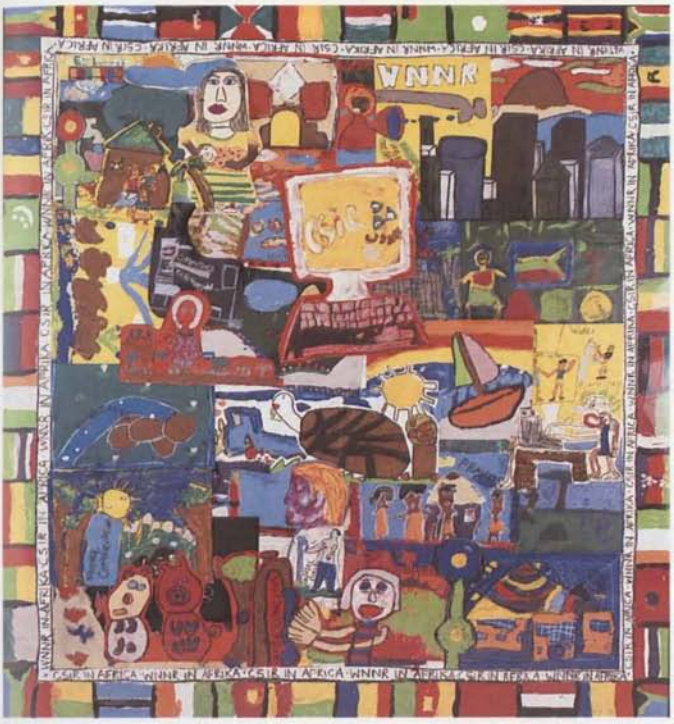
The artificial wetland at the Pretoria headquarters processes the effluent produced by its unique science and technology research environment. An artificial wetland is a particularly attractive and environmentally friendly means to deal with effluent and the CSIR has designed similar systems for several other companies.

Some of the CSIR's other premises:

Above: Stellenbosch main building

Right: Hermanus Magnetic Observatory

Below: Hartebeesthoek Satellite Tracking Station



Top left and right: In 1995 the CSIR's 50th anniversary was marked by the issue of a stamp depicting its contribution to the field of water technology. Dr Donald Masson, CEO of the Post Office, presented Dr Geoff Garrett (acting President at the time) and the then Chairman, Mr Paul Kruger, with a framed commemorative envelope.

Centre right: The CSIR sponsored an art workshop for the children of the staff who were given relevant technology themes on which to base their creations, which took the form of either paintings or constructions.

Centre left: One of the huge collages produced from the best contributions. *(Dewald Reinders)*

Bottom left: The anniversary flowerbed at the main gate of the CSIR's head office in Pretoria.

Some of the CSIR's other premises:

Above: Stellenbosch main building

Right: Hermanus Magnetic Observatory

Below: Hartebeesthoek Satellite Tracking Station

Examples of ancient technology in South Africa as described in Chaper 1.

Above: A gold-clad rhinoceros figurine (100 mm) from an ancient burial site (1220 – 70 AD) at Mapungubwe in the Northern Province. *(Department of Anthropology and Archaeology, University of Pretoria)*

Top right: Stone Age tools from various parts of South Africa. As the development of man advanced, the size of his tools decreased; the designs became more effective and sophisticated and indicated increased dexterity and intelligence. *(Collection: Unisa. Photo: Linton Davies)*

Centre right: Iron Age implements found in South Africa (clockwise from top left): Hoe, sweat scraper, pickaxe, two copper ingots used as currency, iron draw plate used in the manufacture of copper wire. *(Collection: Unisa. Photo: Linton Davies)*

Bottom right: A highly efficient Venda-type furnace with three airpipes excavated near Phalaborwa which characterised the technology of the Iron Age. *(Department of Archaeology, University of the Witwatersrand)*

Below: A petroglyph of an eland, showing an advanced degree of formal interpretation and technical skill. *(Collection Natural Cultural History Museum. Photo: Frik Dreyer)*

In simple words that all can understand
And relieve us in a hurry
Of all the fear and worry
Which they've caused themselves by being underhand.

There are few things that antagonise people more than unfamiliar jargon. Unfortunately part of changing the culture involved learning a whole new language, that of the marketing, management and business worlds. Not being able to accept the 'new-speak' or the extent of change so fast, the suspicion was created that staff was not being kept informed of everything. Jargon remains a constant irritant but is a universal sickness one has to live with.

WEATHERING THE STORM

Early adjustments to the original structure were already made during 1988. Among them were the transfer of the Applied Chemistry Unit to Armscor and the conversion of the Information Services activity from a centre to a fully fledged division. The soundness of this decision has been borne out by the division's continued commercial success and its growing role in providing technology for decision support. (By 1994 its support of small and medium enterprises had outstripped the contributions of all other divisions.)

Towards the end of 1988 Mr Fred Camphor joined the CSIR to head the corporate Human Resources activity, which had been elevated to executive level. Tangible evidence of the Executive's efforts to emphasise its appreciation for employee contributions was in the widening of the scope of its annual merit awards in 1989, previously reserved for recognising prestigious research only. Now called the CSIR Outstanding Achievement Awards[4] the allocations were increased from three to six awards and include recognition of excellence in all fields of endeavour.

A major structural adjustment was decided on during 1989 when the activities of the very large Division of Processing and Chemical Manufacturing Technology were taken into reconsideration. Dr Tony Pizzi[5] had resigned to take up a university career and the director of Water Technology, Dr Daan Toerien, took on the additional responsibility of acting director while the division's future was being decided. During the same year a second director, Dr Jan van Zijl, of Earth, Marine and Atmospheric Science and Technology, resigned to manage the family estate. Dr Harry Swart was promoted to manage this challenging portfolio.

The CSIR had for some time been negotiating the takeover of the South African Forestry Research Institute from the then Department of Envi-

ronment Affairs. This acquisition became a reality in 1990, prompting a merger with the activities of the timber processing research group of the Division of Processing and Chemical Manufacturing Technology to become a new strategic business unit, the Division of Forest Science and Technology, headed by Dr Fred Kruger. At the same time the former division's textile research activities were converted into a fully fledged division, the Division of Textile Technology, located in Port Elizabeth and headed by Mr Jan Becker. The chemical research activities of the now-defunct division were redistributed to strengthen related materials science and water technology activities of the CSIR.

The shift in emphasis to implementation and market orientation highlighted the CSIR's lack of expertise in the commercialisation and industrialisation of products. The appointment in 1990 of commercialisation and business development consultants, who had experience in negotiating contracts and legal expertise, boosted the relevant knowledge base in the organisation and accelerated the desired culture change.

The CSIR had always been involved in small-scale manufacture of specialised items, the proviso being that production facilities or know-how were not available anywhere else in the country and that, if at all possible, the technology would be transferred as soon as a suitable and reliable agent could be found.

The increased emphasis on competing in the open market was bound to create conflict with respect to the CSIR's dual role of managing essential national infrastructural research and development needs, for which government money was being used, and its obligation to earn contract income to support its commercial activities. A comprehensive policy was drawn up to support this issue, covering all possible sources of conflict that might arise from the CSIR's involvement in competitive business. Complaints in this respect are referred to the Competition Board, and not once has the CSIR been found guilty of any infringement.

The new FRD building was inaugurated in April 1989. However, FRD did not become an independent organisation before the relevant Act[6] had been approved in October 1990. The separation of this function from the CSIR brought to an end 45 years of its involvement in the funding of researchers in the natural and engineering sciences at universities, technikons and museums. The constitution defined FRD's main aim as the development of human resources under the leadership of experts – surely one of the noblest and most rewarding causes an organisation could wish for. Little wonder that its President, Dr Reinhard Arndt, claims with obvious enjoyment: 'Arndt has the best job in the country!'[7]

To keep official track of the progress of the culture change, a compre-

hensive survey of staff attitudes was undertaken during 1990. The outcome was mixed, as could be expected[8]. Having accepted the responsibility to steer the new initiatives, management had taken a crash course to understand the new direction and what it required of them. The strong motivation of the members of the top management team, boosted by their initial sense of euphoria, gave them the required momentum to survive the first year, by which time they had grown tough enough to cope with the harsh reality of the commercial world.

At the next level progress was somewhat slower. Staff had accepted the inevitability of change, but the behaviour required to perform the day-to-day tasks associated with the new direction was not yet up to standard. There was a large need for clearly defined structures and systems. The new culture demanded employees who could structure their own work situation. Over the next few years, this gap was steadily eliminated.

An interesting development was the staff's rejection of any overt display of power. It meant that the new flat management structure had been accepted even if it created perceptions of career path problems. However, competitive and success-driven behaviour were easily misinterpreted as a display of power.

The transitional phase was marked by climate swings as the new organisational values became operational realities. The general workforce had not yet broken completely with the culture of the need for knowledge for its own sake, but was gradually accepting the need for knowledge for decision-making, task development and goal achievement.

During roughly the first two years there was fierce criticism and rejection of the new values and vision. Among staff of this persuasion, it was considered stylish to deprecate the Executive and the mission, and to take aggressive action to prove that they were wrong. The kind of talk prevalent was: 'it won't work'; 'nothing's really changed'; 'the CSIR will never change'; 'nobody knows what they are doing, there is only chaos'; 'you can never make money out of a researcher and his research'.

These sceptics adopted a wait-and-see attitude. From their point of view, it was considered 'smart' to leave the CSIR and preferably with a sizable severance package. Those who remained, despite severe reservations about the wisdom of the change had to adapt or leave. The process of adapting was accelerated by the deliberate strategy of emphasising the lack of job security. Management's policy during the first phase of the transition was to communicate by giving information but not to extend this to consultation. This was a very harsh but necessary step and not all managers managed to adhere to it, choosing to adopt a more supportive role. Secure people, however, seldom experience any pressure to mend their ways. Once the reali-

sation had sunk in that it was useless to hanker after what might have been had THEY not interfered in 'Utopia', people were ready to move along the new course.

The first reaction to deal with the uncertainty in a positive way was to find a means of rationalising and redefining a project or position in such a way that it seemed to fit the required pattern of behaviour. Financial pressure usually showed up the flawed thinking and the next step would be a far more realistic one. Unbeknown to the workers, they had embarked on the culture change that would in most cases lead to a complete conversion to the new thinking.

Where staff was either unwilling or unable to learn the new behaviour, and consistently could not meet the performance criteria, the reaction was to blame it on the new system. If this behaviour happened to be in middle management, it was particularly destructive and stressful because it alienated immediate subordinates from the constructive momentum gained in the rest of the organisation. Fortunately, most of the workforce read the environment correctly and understood the reasons that prompted the drastic change. They experienced a growing excitement about the opportunities opening up before them.

The initial strongly negative reaction among the doubtful was gradually replaced by an equally strong need to learn. The emphasis on performance and the shaky economic environment created a climate of fear of losing one's job, and certainly accelerated the acceptance of the new culture. This group became anxious, and gradually desirous, to learn new skills and how best to apply them. There was a strong need to become successful, a need for leadership and support (not just management) during the stressful period, and a need for an organisational system that would ensure high quality and successful work.

Line staff had to learn that the introduction of systems was not the rebirth of bureaucracy but necessary for the successful operation of the organisation. Managers demanded task- and business-oriented behaviour their subordinates were sometimes not ready to give. Where such a gap in development existed, feelings of failure at all levels increased.

The high levels of stress created by the increased performance demands, especially in cases where there were still skills gaps, and the inability to adjust to change had to be dealt with in a sensitive manner. Once the learning phase was established, consultative communication was actively encouraged. Provided learning took place, the philosophy was to be tolerant of mistakes to develop the risk-taking culture associated with entrepreneurship.

The approach of CSIR employees, selected for their innovative and cre-

ative 'big picture' thinking, had previously been unstructured and not focused on results, and it was essential to harness this enormous creative potential.

It was natural that some overreaction should follow in the wake of the radical change and probably in proportion to the exaggerated swing of the pendulum. People, however, are remarkably adaptable, and once staff had entered the learning phase they were soon using business terminology with ease and applying business principles with a familiarity and skill that would make any school of business proud!

The commitment to make the new order work often translated into behaviour that could not be sustained indefinitely. At one stage staff, especially top and middle management, felt like traitors to the cause if they did not work anything from 10 to 14 hours a day and over weekends as well. This was a good sign at the time because it demonstrated a willingness to break completely with the previous clock-watching habits of a substantial portion of the staff. Gradually a sense of moderation and pragmatism emerged when it became evident that over-dedication could be at the expense of family life and stress-related complaints were on the increase. While the pressure did not drop off, people learned to cope with it better. Leaders developed the discipline to create time for themselves and acquired the management maturity to maintain a balanced approach.

Gone was the casual, no-sense-of-urgency approach. Market trends were being watched and analysed, product development became far more focused and contracts were generally no longer signed in gentlemanly good faith, but professionally negotiated and screened for loopholes.

In the old dispensation employees did not consciously analyse or manage human resources, finances, time and physical infrastructure. These actions had become a self-evident precondition for planning procedures, a practice that speaks for the advanced level of professionalism that had emerged. The learning process proved to be exciting, it changed careers even if the employer remained the CSIR – and, yes, it was fun!

While some employees still resent the reduced degree of job security in the new CSIR, others have come to terms with it and recognise its relative positive influence as well. The realisation that sheltered employment was a thing of the past acted as a stimulus to sharpen the wits. People learned to live with uncertainty, without guarantees of having a job in a year's time, without being so certain of material things. This experience was a sobering one and stimulated personal growth. In many cases new skills were acquired which increased employees' marketability. The sense of security experienced by many whites in the past was in fact false. Coping with the new CSIR prepared them to cope with the new South Africa.

On Course 8

Now, here, you see, it takes all the running you *can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!*

Lewis Carroll – *Through the Looking Glass*

AT THE WHEEL

Garbers retired as President at the end of September 1990 with the satisfaction that his team had successfully negotiated the rapids and steered the good ship CSIR into the seemingly calmer waters of the 'roaring nineties'. The Board unanimously appointed the dynamic and charismatic Clark as his successor, at 41 the youngest person ever to assume the responsibility of President.

Garbers's departure, coinciding with the achievement of FRD's independence, left the Executive depleted by two members simultaneously. The growing business of the CSIR was becoming increasingly demanding and the Board decided to adjust the executive structure to deal with the current situation. Drs Geoff Garrett and Daan Toerien, having distinguished themselves as directors of their respective divisions, Materials Science and Technology and Water Technology, were appointed as Executive Vice-Presidents to share the operational management load, while Mr Mike Groch was appointed as Executive Vice-President of Marketing and Business Development, finally elevating this important function to executive level, along with finance and human resources. Garrett and Toerien's jobs were filled by two talented youngsters from within their respective divisions, Drs Adi Paterson and Ben van Vliet.

The end of 1990 also marks the entry of the first trade union activity

at the CSIR. The National Education, Health and Allied Workers Union (Nehawu) entered into an agreement with the CSIR and would in future collectively negotiate salary scales for the category of general workers. The outcome of such negotiations would affect workers whether they belonged to the union or not.

During 1991 Dr Louw Alberts retired as Chairman of the Board and Mr Paul du Plessis Kruger, Chief Executive of Sasol, was appointed in his place.

The new executive team, eager to move forward, commissioned both internal and external audits in 1991 to assess the CSIR's progress in business orientation. The findings showed up the shortcomings in the otherwise successful transition. It was evident that more training was required in project management and in developing business skills. Proper feedback and control systems in management needed attention, as did the inability to exploit the CSIR's full strength by working effectively across divisional boundaries.

External recognition of the CSIR's successful transition was becoming evident. The audit of business opinion confirmed that the CSIR had been accepted as an established strong, professional, outward-oriented organisation, but was now tainted by an image of undue commercialism and relating only to 'big' industry. Fears were expressed about overemphasising short-term financial performance. The audit also showed that there was room for improvement in the CSIR's ability to deliver what was promised and in meeting deadlines. While its products were seen as good, the CSIR's fees and prices were considered high. The impression was that there were too few engineers and technologists relative to scientists. Nevertheless, the CSIR was judged as superior in terms of its competitors and peers with regard to strategic importance, credibility and standard of service.

Managers took note and implemented corrective measures. However, as they were aiming for high quality, they were not perturbed by the commercial world's perception of the CSIR's pricing policy. What was at stake was the value of the product and quality of the service delivered.

Government and industry presented contrasting views, as could be expected, given the CSIR's dual role. Government departments saw the CSIR as the scientific arm of government and thought it should not be forced to greater commercialism to compensate for the shrinking Parliamentary grant. On the other hand, industry viewed the CSIR as critical to the upgrading of the country's technology base and emphasised the initiative of transferring technology, from local and international sources, to assist exporters to become more competitive in world markets.

While attending to the shortcomings highlighted by the feedback, man-

agement was convinced that the CSIR's transformation had been sufficiently established and that the time had arrived to increase the emphasis on longer-term directed research. To enhance its credibility, the CSIR needed to step up its publicity of success stories in development and implementation.

The audits showed that the initial strategic initiatives had gelled and needed only periodic fine-tuning, dictated by practical developments within the organisation and the changing market and socio-economic environment beyond the CSIR's gates. The realisation of this milestone added to the confidence of the management team. They had basically made sound decisions and could move forward by using the existing framework.

Part of the CSIR's original brief was to maintain offices abroad to channel relevant information from the best sources to the researchers, a service that was extended to the entire scientific community of the country. Over the years, offices had been established in London, Washington, Cologne/Bonn, Paris,Teheran and Los Angeles, and Japan was under consideration.[1] In the process of restructuring, this service was administered by the FRD, but was transferred to Information Services in 1989. Named CSIRIS, for obvious reasons, its task in the new dispensation was to scan the technological environment to keep the CSIR up to date with international developments.

The cost of maintaining these offices, however, placed a question mark over their future viability. During 1991 the overseas liaison office in Paris was closed, with the London and Bonn offices taking over its responsibilities. As the offices had always served the entire science and technology community and not the CSIR alone, an unsuccessful attempt was made to broaden their mandate even further, that is to serve and consequently receive funds from the Departments of Foreign Affairs, National Education, and Trade and Industry.

Internal communications were given a high-tech boost by the installation of a local area network (LAN) system. The link-up with the existing electronic management and information systems gave staff immediate access to a whole range of information facilities. Being able to relay documents and messages at lightning speed saved paper, time and labour. The personal computer soon became a standard item in the range of specified office equipment.

The availability of an electronic bulletin board was a revelation. Suddenly the entire CSIR community was in touch with fellow members whose humorous streak had hitherto only been known to their immediate colleagues. The bulletin board became a vehicle for the latest jokes, test match scores, micro-enterprises peddling fresh farm produce or second-hand goods, information on good or bad service in town, speed trap warnings, com-

plaints aimed at management, moral guidance – the possibilities as endless as human endeavour. As anonymity is virtually ruled out, it soon becomes apparent if someone spends too much time on the facility and culprits suffer the consequences. The inherent advantages of building a Team-CSIR spirit and acting as a safety valve, with the bonus of having ongoing insight into the psyche of the workforce, outweigh any disadvantage of a few minutes spent on surfing the system. The addition of the *Tarentaal*, an on-site watering hole, open for the after-work happy hour(s), further strengthened the reawakening camaraderie.

Rapid developments in information technology prompted management to streamline the CSIR's activities in this area. The Centre for Advanced Computing and Decision Support, the Division of Information Services and the Management Information Systems Programme were restructured in 1991 into one unit, retaining the Division of Information Services as its umbrella name, with Dr Ben Fouché as director. Dr Duncan Martin, former director of the centre, opted for a career at the University of Cape Town.

The divisions' annual reassessment of their portfolios identified non-viable activities, which were closed down if management was satisfied that they held no long-term potential, the associated staff being accommodated elsewhere in the organisation, where possible, or retrenched.

Each one of these decisions were preceded by a thorough analysis. With limited resources, hard questions needed to be asked. Great care was taken over retaining key skills, a very sensitive issue, as vested interests in a field unleash strong protective instincts. Such emotions make it difficult to accept that the future is not necessarily an extension of the past, in which case the CSIR would still be investing in valve technology.

By 1991 the management team had distilled five core values to keep the CSIR on course – being market-oriented, technology-based, people-oriented, quality-focused and output-oriented. These values serve as guiding principles in an unstable environment. They are timeless and provide a framework, a philosophy according to which people operate. The assimilation of sound concepts like quality and delivery helped to instill confidence in the chosen course.

One of the mechanisms the Executive used to accelerate the culture change was the practice of inviting a small cross-section of staff to breakfast with a member of the Executive during which they could discuss their experiences and problems in the new CSIR. The presiding executive would casually start discussing the merits of these core values. A lack of participation through ignorance was highly embarrassing and the word spread quickly.

The feedback provided by these sessions and the regular monitoring of

the progress during the transitional phase kept the Executive's finger firmly on the pulse of its healthy creation. Top management could take the necessary corrective action to move the change process along and could react swiftly to redeploy its resources in line with market dictates, both on the local and international fronts.

The effect of the CSIR's reorientation had up to now served to help local industries to be more competitive with respect to each other and as a sanctions-busting exercise. However, South Africa's international relations were slowly beginning to change in the wake of the release of Nelson Mandela and the implications for a future democratic government. European countries and the USA started showing increased interest in the CSIR, but were concerned about the state of its technology after South Africa's prolonged isolation. The CSIR had been blacklisted in the USA and a 'wait-and-see' attitude kept contact to a person-to-person level.

The prospect of future elections and a new government focused attention on a new approach to science and technology policy to support national socio-economic initiatives. The CSIR commissioned a UK-based international consultancy[2] to undertake a comprehensive international science and technology policy study in 1991 which eventually involved 17 countries. The findings emphasised the importance of managing technology effectively within an efficiently functioning overall innovation system. Firstly, competence in basic enabling technologies was a prerequisite for a country to be internationally competitive and part of the research and development effort had to be so directed to use these technologies effectively. Of the utmost importance was the need for research and development on country-specific problems and opportunities. The CSIR would in future adapt its strategy according to these findings and increase its efforts to play a leading role in formulating science and technology policy. The importance of this decision was underlined by the appointment in January 1992 of Dr Gideon de Wet to direct a CSIR policy unit.

The CSIR's focus on Africa was supported by the creation of a corporate office in 1991 dedicated to co-ordinate the growing contact with African countries. A strategy to utilise overseas technology and adapt it to African requirements extended its ability to serve its neighbours.

On the home front, this initiative was followed by the creation of a Technology for Communities programme in 1992. Several divisions had been providing technology to communities for many years on a project-specific basis, for example, in the fields of water, food and housing. Prompted by a growing sense of responsibility to the communities, it became evident that the extent and diversity of their needs required a co-ordinated multidisciplinary approach.

To optimise the CSIR's support for the manufacturing industry, the Executive commissioned a comprehensive study in 1991 of this important sector of the economy. The findings published in 1992 led to a review of the activities of the Division of Production Technology. At the same time the decline in the Government's investment in defence research signalled a partial adjustment in the strategy of the Division of Aeronautical Systems Technology. Because of the many complementary activities and skills in the two divisions, the Executive decided to merge them into a single division in November 1992. Named the Division of Manufacturing and Aeronautical Systems Technology under the directorship of Dr Johann Fritz, this new powerhouse was further strengthened by the consolidation of associated specialised activities involving the transfer of specialists from Building Technology and Materials Science and Technology engaged in complementary activities. Dr Maurice McDowell, former Director of Production Technology, stepped down to head the Optical Engineering activity within the new division, but left to start his own company during the next year.

To improve the communication of its achievements and capabilities to the business world, the Executive launched a monthly news bulletin, *Technobrief*, in April 1991. It took the form of a tabloid with short punchy items on the latest developments at the CSIR, replacing the quarterly journal *Scientiae* which concentrated on long informative articles. *Technobrief* has become a source of numerous enquiries often leading to the conclusion of new contracts. Items reproduced in other publications like the *SA Product Digest* have elicited enquiries from all over the world.

As a result of the CSIR's successful transformation, it was being approached more and more, both formally and informally, to consider taking over other organisations. This trend necessitated the creation of a special policy to handle these requests responsibly. Issues such as potential competitive advantage, sales, technological congruence and culture fit receive rigorous scrutiny. Other considerations are overall attractiveness, the cost of entry and whether the CSIR would truly be better off with or without the acquisition. The overriding principle is that management should concentrate on making the existing CSIR operate efficiently and effectively.

Public recognition of its success was becoming evident such as being awarded Safto's Business Development Award in 1992 while in the same year the CSIR won the 1991 Technology Top 100 Prize. Since then individual divisions have consistently made it into the South African Technology Top 100 Club.

In line with its heightened business awareness, the CSIR embarked on an intensive safety drive in 1990. It had previously complied with the rel-

evant legislation, but there was no formal system in place to drive the process, resulting in a reactive approach. This situation was rectified by the introduction of a comprehensive occupational health and safety system, largely based on the National Occupational Safety Association (Nosa) system. These measures achieved a Nosa three-star rating during its first grading in 1991. Since then the CSIR has successfully attained four-star ratings at all its major centres countrywide.

During 1993 a more holistic approach was adopted which included environmental management. The department's name changed accordingly to Environment, Health and Safety (EHS). The EHS systems are reviewed annually in order to keep pace with changing legislation, needs and practices. By 1995, five divisions had achieved individual ratings of five stars according to the CSIR's internal assessment, with the remainder operating on four-star levels.

1992 turned out to be a year in which leaders were highly mobile. Mr Patrice Laserre, General Manager of the Technical and Site Services Department and Mr Albert Michau, Executive Vice-President, Finance and Management Services both resigned. The Executive Board decided to make a number of portfolio adjustments, among them being the appointment of Dr Charles Freeme, Director of Roads and Transport Technology, to head the London liaison office and Mr Roy Page- Shipp, Director of Building Technology, to become Director of Corporate's Special Projects activity. During the same year the Executive launched its CSIR Fellowship Scheme, according to which truly outstanding researchers are given the status of Fellows of the CSIR. They do highly specialised work in areas earmarked for development and assist with the mentoring of young researchers. Dr Piet Steyn, Director of Food Science and Technology became the first to be so honoured.

CAPTAIN'S LOG

By 1992 the dust and the pendulum seemed to have settled, and the transformation from a largely academic to a contract research organisation was all but complete. The extent of change was clearly visible. The rationalisation had resulted in a restructured and much leaner organisation. Apart from the change in attitude, a gradual change in the mix of staff had taken place. New appointees carried no baggage and accepted the new order without question. As management's understanding of their own creation grew, the profile of newly appointed directors and programme managers changed to include not only scientific and managerial excellence but also exposure to industry and the business world.

The organisation had changed from a largely static, ivory tower-type of

environment, where labels, status, position and hierarchies featured strongly, to a dynamic power house, characterised by a flat structure with the emphasis on useful innovations and entrepreneurial drive.

Staff had been skilfully guided to become market-oriented and then progressed to become market-driven. Starting from a position of total ignorance about marketing, the concept was initially associated mostly with promotion, but gradually an understanding developed that it encompassed a whole process from market analysis and product development to final delivery and the maintenance of client relationships. The functions of marketing management became more clearly defined as business development on the one hand with a marketing support services component on the other. Divisions were urged to appoint business development experts to put marketing on a more professional footing.

Strategic planning had become part of the culture and reached down to middle management levels. A mission statement, clearly defined goals and objectives, the introduction of new financial, marketing and human resource systems, and provision for evaluating progress gave the organisation a distinctly different character. Its whole vocabulary had changed. Strategic documents were produced annually in great detail and did not fit comfortably into an ordinary briefcase.

This practice became considerably more sophisticated with an associated reduction in size and in content of the documents. The bugs had been sorted out for the most part and policies, objectives and actions that had to be spelled out at first had now become accepted practice and part of the culture. Management had gone through the process of quantifying its intuitive knowledge with computer-supported analysis of strategic options and emerged with the confidence that their educated 'gut feel' could be trusted.

Staff had grasped the concept and importance of strategic planning in an unstable environment, as opposed to mere planning. Alternative sets of plans were being prepared for different scenarios should any one of a whole host of variables change. The realisation had become deeply embedded that a competitive world demanded the CSIR to be ahead of the field in order to survive, and even more so to thrive. In a stable environment it is easy to extrapolate from existing plans to cover long-term developments because they are fairly predictable. There could no longer be any doubt that the CSIR would be operating in an unstable environment for some time to come.

The management and leadership style was probably the biggest evidence of the transformation especially among the higher levels. In the early days the emphasis had been on research leadership with little formal attention being paid to management. During the transformation process, man-

agement became all important to the point of overemphasis. Gradually the emphasis shifted back to leadership, but leadership of a much more comprehensive kind, in tune with the demands of the modern environment. The CSIR has always attracted good people who produced great ideas, but they had limited impact on the environment for a variety of reasons. There was no mechanism to enforce the CSIR's original mission, nor any motivation to change direction – in effect, the scientific leadership followed the well-trodden Western route of the 1950s without making too serious an attempt to adapt to local realities, aided and abetted by the prevailing political system.

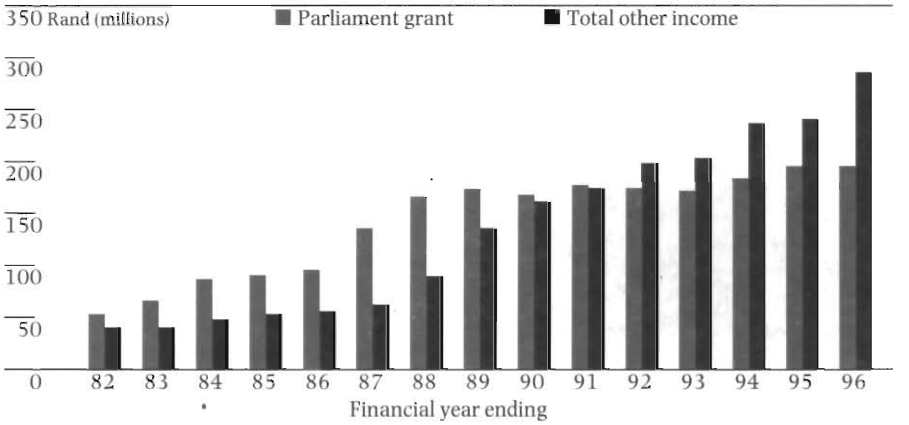
There was a marked shift from fundamental to applied research, the former being carefully selected to align with anticipated future national needs. The range of product offerings had changed considerably. Many products were previously developed following some brilliant insight only to be met with stony silence in the marketplace. This did not change overnight. Mistakes were made, in the wake of which proper screening processes were introduced to ensure time was not wasted on non-viable products. Product development was further complicated by the downswing in the economy resulting in companies being less interested in new products. Business concerns put investment in new ventures on hold and the emphasis shifted towards services.

Despite this, the CSIR made substantial progress in increasing its income from the private sector, on the strength of which the CSIR's income from external sources had overtaken the value of the Parliamentary grant. Success, however, was not attributed according to income only, but also to the increased extent of involvement with the country's industry and the growing technological support for its communities. The steady rise in its client satisfaction index is a measure of its successful conversion to a business culture (*see* graph overleaf).

A shift in approach had evolved to fit the new philosophy. It no longer mattered whether scientists were involved in high or low technology, as long as it was good technology, appropriate for the task in hand. For example, inexpensive, less sophisticated, but perfectly adequate, methods to measure air pollution are currently being used in developing communities. The community members' active involvement in collecting the information serves to raise their awareness of air quality and the impact of pollution on people. The sophisticated component lies in the skill it takes to interpret the data.

Performance criteria had changed quite drastically. The emphasis is on output regardless of formal qualifications and seniority. The culture change had started – often under duress to hold on to the job, but also prompted, at varying rates, by a growing confidence in the new approach.

CSIR Income



Even the buildings and the terrain reflected the new orientation. Entrances, reception areas and directors' offices were redecorated in line with smart business practice. The up-market look is gradually working its way through to programme managers' offices and those offices that still bear the distinctive stamp of the old-style civil service, as did some of their former inhabitants.

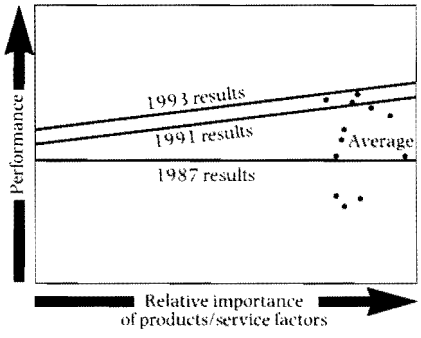
The old *laissez-faire* cleaning service gave way to smarter uniformed workers with a professional trolley of tricks, whose services had to be paid for. As divisions were charged rent per square metre, space requirements were toned down without a corresponding sacrifice in productivity.

Major organisational change is exceptionally dependent on the right timing and the environment. The role that timing, or maybe even luck, played in the restructuring cannot be underestimated. Five years later, the environment was entirely different and a similar process of change may have been all but impossible. Major change has a much better chance of succeeding if action is taken well in advance of the events that influence the destiny of an organisation. Many organisations undergoing change as a result of market pressures are not afforded the time to put proper mechanisms in place to cope with the new environment. To succeed in this feat, the organisation must have the right conditions and people to make it work. The CSIR had already embarked successfully on doing high-level contract work for industry and could build on this experience; adequate funding was available to accomplish the transformation, and it had a unique combination of leaders who diagnosed the situation in good time. This was the situation for a classic window of opportunity.

When the CSIR embarked on its new course, there was no indication of the revolutionary changes that were about to take place in the environment

Customer Satisfaction surveys (1987–1993)

Factors of product/service researched in order of importance as seen by the market:



1987 &'91	1993	
1	1	Delivery of what is promised
4	2	Maintenance of high standard of research, development and implementation
2	3	Commitment to the client's project
5	4	Meeting of deadlines
7	5	Keeping up to date with world technologies/information
3	6	Insight into and understanding of client needs/problems
	7	Effective transfer of information and deliverables on project completion
6		Confidentiality/security of service

Below average in all aspects of customer service in 1987, the CSIR has progressively improved its performance, particularly in those areas considered by clients to be of most importance (as listed).

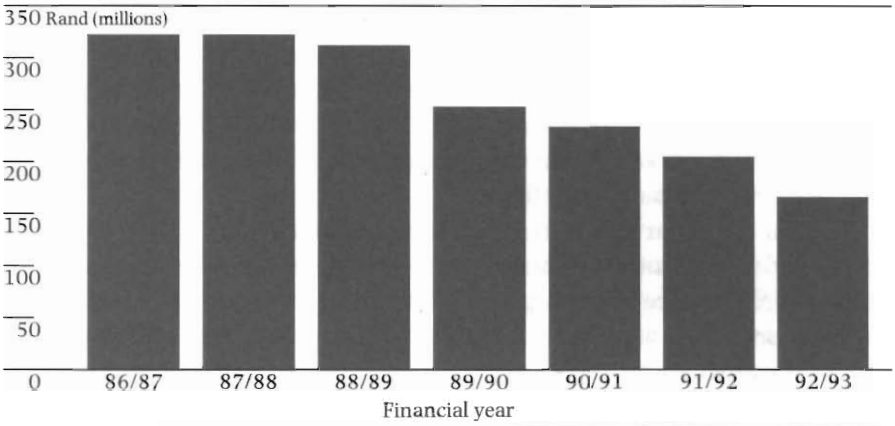
in the next few years. Thus the change process was seen at the time as a one-step process. With what knowledge they had, the change managers were going to turn the CSIR upside down, create a whole new organisation and then manage it. The language used was that of 'making it work', of 'just getting through this phase', 'biting the bullet', and so on. The vision was clear, but there was no road-map. They were embarking on new territory and had to deal with every new situation as it presented itself, without ever losing sight of the destination.

Somewhere during this process, the rate of internal change took off dramatically. It became apparent that they were dealing with a new organisation. The process was no longer one of simply maintaining the change initiatives. The management team had succeeded in building into the genes of the organisation the ability to cope with the changing environment, to deal with whatever would happen to it. While obviously elated with their achievement, this realisation filled the management with a sense of deep responsibility.

The changes the CSIR introduced in 1986 marked a new phase in the evolutionary process evident in research councils, a reaction to, among others, the severe economic pressure to which these councils have been subjected the world over. In the UK, Harwell made its move in the early 1970s, while in Australia the CSIRO did so in 1979. The CSIR became convinced that its overseas counterparts, who had opted for less drastic measures under the pressure to change, had not achieved the level of culture change the CSIR was aiming for. In many instances the CSIR had moved much further along the line than its peers, and the management and implementation of the transition would rank among the very best in the world.

Five years down the track, the change managers were acclaimed for their

Parliamentary grant to CSIR (constant 1992 Rands)



courage and vision to persevere in the face of much resistance and antagonism. They have the satisfaction today that their grim adherence to the chosen course has been vindicated. Few people can doubt what the consequences would have been had the CSIR not taken this radical step, given the declining Parliamentary grant at a time when technology had been identified as the driver of economic development. Apart from the advantage of mere survival, the move was in the best interests of the country. Had the CSIR not remained close to its environment, it would not have been in a position to deal so readily with the changing needs of the new South Africa. With hindsight, some of the actions taken could have been handled differently, but as far as the big issues are concerned, the change managers 'got it right'.

How did a science council of a small country with a limited number of scientists and technologists achieve so much more than many of its more sophisticated counterparts? The answer has many facets. It was fortuitous that the composition of the Board at this crucial time consisted of a high percentage of the country's foremost industrialists and academics. In fact, all its members were hand-picked for their personal attributes, a combination of technical excellence and managerial experience. The courage and integrity of Garbers, the vision and drive of Clark, the quality and commitment of the top management team to implement the revolutionary initiatives with the co-operation of a workforce of exceptional vitality and resilience, formed a unique and dynamic force that made the transformation possible. The planning was excellent and the Board guided the process expertly and backed the initiative to the hilt.

The strain of all this success, however, took its toll. Having succeeded in achieving its goals for two or more years running after such a revolu-

tionary phase, management no longer felt it had the freedom to fail and was inclined to take less risks. There is a positive as well as a negative aspect resulting from this learning experience. A successful conclusion is the obvious goal, but it is tempting to simply build on one's success. In the beginning there were a multitude of options to choose from. Having found a number of options that worked, it was easy to slip into the mode of repeating them and to lose the former flexibility.

Regular client surveys were quick to show up a slight slip in responding to clients' needs and in adhering to agreed deadlines and budgets, the constant nightmare of the high-risk research environment. The lesson to be learnt from this was to reinforce the former strategic interventions and regain the empowering risk-taking mode. Fortunately the Board too kept a close watch on the progress and diagnosed an inherent weakness in the implementation of the carefully designed strategies. Management had concentrated very hard on establishing the culture of strategic planning, but had not emphasised sufficiently the implementation of the resulting plans. The next phase in the CSIR's evolution would be characterised by strategic management, combining strategic planning with implementation.

Longer-term reactions to the exaggerated pendulum swing aimed at enforcing the culture change were beginning to crystallise and would exact a price too. An undercurrent of criticism was surfacing against perceptions of concepts such as management by bottom line, erosion of the knowledge base, and the lack of real commitment to staff orientation, among others.

A GOING CONCERN

The CSIR's multidisciplinary capability is an obvious advantage, and effective mechanisms had to be found to exploit it to the full. One such mechanism is the system of corporate programmes to co-ordinate related activities located in different divisions. The first initiatives were directed at the environment, the automotive industry and mining. Events over the next few years led to both the environment and mining activities reaching full maturity when they became fully-fledged divisions.

As a corporate programme, the Environmental Services group's function was to provide solutions to environmental problems such as environmental management and the commercialisation of related products and services. An example is the much publicised environmental impact assessment of the eastern shores of Lake St Lucia in KwaZulu/Natal. The study required among others the expertise of geologists, marine scientists, water, forest and mining experts, all of whom could be drawn from CSIR divisions. The group also contracted and co-ordinated other skills, for example, legal expertise from outside the CSIR.

A concerted drive to support the local automotive industry initially met with limited success owing to a depressed economy and because most local manufacturers traditionally depend on their parent companies overseas. However, the development of customised automation machines for local production runs and support for local component development have thrived and seem set to continue doing so. Since the activity became concentrated mainly in one division, the need for a centralised corporate programme became superfluous.

Political developments prompted increased awareness of the CSIR's responsibility towards the upliftment of communities. From 1992 a Technology for Communities programme has co-ordinated existing activities in the CSIR and expanded its means for improved interaction and establishment of needs.

Information technology (IT) expertise is represented in virtually every division of the CSIR and is in itself a common denominator and basis for co-operation. The activity has not been converted into a programme, because IT is seen as not necessarily conferring competitive advantage in itself but as an enabling technology.

As many divisions in the CSIR have links with the manufacturing industry, it was important to develop a co-ordinating strategy in manufacturing technology. The findings of the study the CSIR commissioned emphasised that markets had become internationalised and South Africa's manufacturing industry now had to compete in the global league. Capital, raw materials and expensive labour no longer determine where manufacturing operations should be located. The quality of labour management and technology are the important competitive factors. Manufacturing process technology is of pivotal importance, while product technology is more easily copied. The best course for the CSIR was to identify groups of related and supportive industries and to develop a very specific focus in line with its resources.

As a starting point to implement this strategy, the CSIR created the Corporate Industrialisation Group to co-ordinate key manufacturing-related skills across the organisation and to serve as a single entry point for the manufacturing industry. A vigorous export-oriented manufacturing industry is seen as the key to achieving economic growth, with accompanying benefits for socio-economic change. The network is aimed at optimising the CSIR's manufacturing support capabilities and to draw on the expertise from the relevant divisions to industrialise selected CSIR intellectual property. The final major component of the manufacturing strategy is to ensure close collaboration with both Government and industry in developing and implementing a coherent national industrial and technology policy.

By 1993 it had become clear that the venture capital company, Technifin, was not performing according to expectation. Although the downswing in the economy was partly to blame, the main reason was that product development was primarily channelled through technology partnerships. This pattern did not apply to the CSIR alone, but also to other public and private technology sources. The company was operating in competition with the Innovation Support Fund, administered by the IDC, a 50% equity holder in Technifin. Thus, only in rare instances was assistance sought from Technifin.

Technifin was however very successful in technology licensing, and its structure was consequently altered to concentrate on this aspect and to expand its business in the international market. Technifin sifts through about 2 000 patent applications a year of which three to five will prove to have potential for international success. It has built up a portfolio of some 16 projects, which are at different stages of development.

Among the most important ones is the technology developed by the CSIR involving lithium battery materials for use in rechargeable batteries, for which a licence agreement has been finalised with Sanyo, Japan. Other inventions include a purification method of an important enzyme, which is expected to enter the Japanese market in 1996; a process for high-resolution printing on leather products, presently being tested by Toyota South Africa; a cable conduit system ready for exporting to Europe and the USA; and an OED inkjet plotter for export to Europe.

Technifin is a partner in these technologies, responsible for financing the patent protection of the inventions and helping to identify companies, both locally and abroad, for producing the inventions. It concludes appropriate licence agreements, retaining 50% of the royalties. Gross annual income is about R1 million with a projected increase to R4 million by 1999.

As support for the overseas liaison function (CSIRIS) was not forthcoming from sources other than the CSIR, its staff started contracting their services to interested parties, to decrease the financial burden of maintaining the offices. Although their efforts met with some success, it was not enough to cover the full cost.

By 1993 it had become clear that the changing needs of the CSIR demanded skills to serve specialised technological and market needs, skills these offices could not always provide. Their selling of information on the open market often resulted in supplying the competition with information while the CSIR was subsidising their services. Management resolved the situation by closing down the remaining overseas offices, in London, Washington and Bonn, and established an International Relations Unit at the CSIR head-

quarters in Pretoria. A specialist team under leadership of Dr Reinie Biesenbach has since operated from Pretoria, travelling abroad when necessary and buying in the skills of foreign consultants when appropriate.

The vacancies, resulting from natural attrition and the reshuffling of responsibilities among the top management team during 1992, were all filled by appointees from outside the CSIR. In the course of 1993 Mr Anthos Yannakou was appointed Director of Food Science and Technology, Dr Hoffie Maree of Roads and Transport Technology, Mr David Bath of Building Technology and Mr Albert Jordaan became Executive Vice-President, Finance and Management Services. Their collective industrial and business experience, strengthened by the growing practice of appointing business development experts to individual divisions, put the seal on the CSIR's business orientation.

This infusion of new blood introduced a new dimension into the CSIR, increasing the number of hands-on practical managers in the top management team. Attracted by the opportunity of making a contribution on a national level, the newcomers are unanimous that they would not have joined the CSIR had it not transformed itself. On closer inspection they too observed that the process had lost some of its momentum. The no-nonsense practical approach that was emerging among the leaders, as opposed to the more traditional theoretical one, began to show up some unintended results of the new dispensation.

In its effort to embrace business principles, management had put too much emphasis on management per se. Scientists-turned-managers subjected the discipline of management to the usual analytical treatment to become super textbook managers. They could quote the latest wisdom of a host of international business gurus at the drop of a hat to the utter amazement and dismay of the more practical newcomers. While this novelty was running its course, it had the effect of slowing down the action in some instances. Technical staff felt themselves of lesser worth as the process rewarded management above all else, while commercial thinking reigned supreme. The new appointees strengthened the trend to simplify the complications caused by this textbook approach, which was also impractical to communicate to middle- and lower-management levels. The effect was particularly evident as their divisions were revitalised and spurred to greater action.

The successful conversion of the CSIR to commercialism had another unintended effect. The commercial orientation carried the message that working with the private sector was the highest good, and in the process the public sector became increasingly neglected. As the main business of divisions specialising in infrastructural technology lies with the public

sector, staff developed guilt feelings about their lack of performance in the private sector. The CSIR lost several contracts with the public sector and staff were severely traumatised by subsequent retrenchment actions. The remaining staff were badly bruised, adopting defensive behaviour and operating in barely maintenance mode. People operating in such a threatening environment and atmosphere of uncertainty tend to start looking out only for themselves.

The new directors appraised the situation objectively, and once employees were reassured that the public sector was indeed a most important customer they could get on with the job and start repairing the damage. The relationship with the public sector required a different approach than the client/contractor one, although many of its sound business principles put the relationship on a much more professional footing than before. A turning point had been reached and the CSIR could stem the flow and start planning for growth.

The CSIR began to realise that as a contract research organisation, run on business principles, it had much in common with many private sector companies. They too grapple with establishing integrated behaviour, agonise over centralisation versus decentralisation and selecting appropriate management styles. They too have to work increasingly harder to remain competitive and face complicated strategic decisions.

Discussions on the incorporation of the Chamber of Mines Research Organisation (COMRO) had already started in 1991 and continued over the next two years. Beset with productivity problems and a falling income, the mining houses were hard put to maintain their mining research operations and COMRO had to consider its options. The activities of COMRO and the CSIR were found to be highly complementary. A pooling of resources would broaden the expertise base for the mining research and development available to the country's mining industry, while both organisations would have access to a larger number of clients. In March 1993 COMRO became part of the CSIR and absorbed the corporate programme co-ordinating mining research, as well as related activities in other divisions, to become the Division of Mining Technology. For the first year Vice-President Garrett acted as Director to guide the complex process of integrating COMRO into the culture and systems of the CSIR. The acquisition of this prestigious organisation underlined the successful conclusion of the CSIR's transformation and its inherent vitality.

The new CSIR was by all indications a going concern, but any feelings of complacency were short-lived. The organisation was about to enter an era of change that would challenge if not surpass the extent of its previous revolutionary transformation.

Watershed 9

He that will not apply new remedies must expect new evils: for time is the greatest innovator.

Francis Bacon – Essay: *Of Innovations*

TURNING OF THE TIDE

1993 would prove to be a watershed year for the CSIR. The inevitable changes that were to follow the release of Nelson Mandela in 1990 were beginning to take shape. When Clark assumed control during the same year, he set himself the task of looking ahead to anticipate the events that would influence the future of the CSIR. A new government, representing the majority of South Africans, implied different priorities in the field of science and technology. Clark embarked on a campaign to make contact with the future decision-makers and key players in this field.

This logical move was met with much cynicism in the circles targeted for contact as well as in conservative circles within the CSIR who criticised him for attempting to ingratiate himself with the future powers. The former received his approach with a guarded welcome, many construing his overtures as pragmatic self-interest aimed at protecting the CSIR's Parliamentary grant and by the same token his and his colleagues' jobs.

Maintaining the continent's strongest science and technology infrastructure, however, has to be of primary importance to not only the CSIR but also the government of the day, considering its value to industry and the technological wellbeing of the nation. It took some time for both parties to overcome the mutual mistrust and prejudice created by a colonial tradition of long standing and decades of apartheid. Once these barriers

started crumbling it became apparent they had much in common as both were striving to entrench the role of science and technology in a future democratic South Africa. Co-operation was the most obvious and constructive option to pursue.

In 1991 the ANC, Cosatu and the SA National Civics Organisation (Sanco) commissioned the International Development Research Centre (IDRC) of Canada to sponsor a study on an appropriate science and technology policy for South Africa. The study group was made up from both international and local members under the leadership of Mr James Mullin from Canada.[1] The mission members and representatives of organisations affiliated with the Democratic Movement gave their views on a suitable science and technology policy for the country, after which the conclusions and recommendations were referred to representatives of the existing science and technology system of South Africa, including the CSIR, for comment.

The final version of the report, *Towards a Science and Technology Policy for a Democratic South Africa*, which appeared in July 1993, summed up the study group's assessment of the various science and technology-related bodies and highlighted the important needs to be addressed. These included the necessity of applying technical skills to the real development needs of the majority; for the scientific community to recognise its African location; for commitment to national affirmative action programmes based on non-racist and non-sexist principles; and for the science and technology community to become active participants in formulating the new policy.

The CSIR was seen as 'a very significant South African investment in scientific research' with 'modern facilities and a tradition of technical competence'. The study recognised the CSIR's successful transformation enabling it to support large-scale industries to compete internationally. However, in line with government's neglect of small and medium enterprises, the CSIR too had not focused on industrial extension services or financial support programmes geared to the needs of these enterprises. Its efforts in giving technological assistance to developing communities too were considered to be inadequate, especially as far as interpreting the complex dynamics of these societies were concerned. The CSIR's existing involvement in Africa and association with the World Bank, the study concluded, could benefit from 'discussing with major donor agencies the lessons of the past'. The report was welcomed as a breath of fresh air even in previous government circles.

The IDRC study emerged as the shaping force on the local scene. Following the study, a Science and Technology Initiative (STI) was formed. This was

to play an extremely positive role in stressing the importance of science and technology in the country's economy. Brian Clark and Jayendra Naidoo were elected Co-Chairmen of the STI, which became the most inclusive forum on the science and technology in the country. This manifestation of co-operation was all the more significant considering the positions from which the parties started. Dr Frene Ginwala, Director of the ANC Research Department, approached her first meeting with representatives of existing scientific bodies with thoughts of 'supping with the Devil', while they came to the meeting with little hope of finding a sympathetic ear for their quest to 'save science'.

At the conclusion of the IDRC study, the CSIR contracted Mr James Mullin for a three-month period to give CSIR staff the benefit of international learning and experience of supporting small and micro-enterprises and developing communities. This event as well as the CSIR's, and particularly Clark's, active involvement with the IDRC study and the resulting STI formed part of the CSIR's drive to assess the environment and ensure the CSIR's ability to be proactive. These initiatives contributed greatly to bringing the strategic insights back into the organisation and culminated in the 1993 strategic review aimed at aligning the CSIR with a much broader range of the country's needs.

Before formulating its new strategy the Executive commissioned a consulting agency to undertake an extensive survey to guide their thinking. The initial briefing was to survey both external and internal stakeholders to gain insight into their needs, opinions and perceptions, which were critical for the CSIR in positioning itself for its future role. The survey was particularly welcomed by future government respondents, female and black CSIR employees, among them the shop-stewards representing Nehawu. These constituents saw the survey as a first step in a process of ongoing communication and co-operation.

The survey immediately picked up the resentment created by the Government's education policy established in 1953 that virtually condemned the vast majority of blacks to an unskilled labour class. The lack of commitment to a proper education in science and mathematics resulted in generations of technologically and economically disempowered people. No wonder too that many blacks saw the CSIR, which epitomised science and technology in the country, as a manifestation of the Government's efforts to empower the white community and 'to further deprive and oppress the black community'. This impression was strengthened by the veil of secrecy that obscured the CSIR's activities aimed at sanctions busting and armaments development. The CSIR was 'that mysterious place in Pretoria where people were experimenting with bombs' and manufacturing

poisonous gases to help the Government suppress the disenfranchised majority.

The emerging stakeholder groups firmly believed CSIR management to have been 'willing and conscious participants in the political use of a national science and technology facility'. In this they were correct. The CSIR serves the government of the day, but the respondents were largely unaware of the bulk of its activities aimed at the private and public sectors as can be seen from a breakdown of its sources of income at the time. The CSIR clearly had to address these perceptions in as honest and constructive a manner as possible.

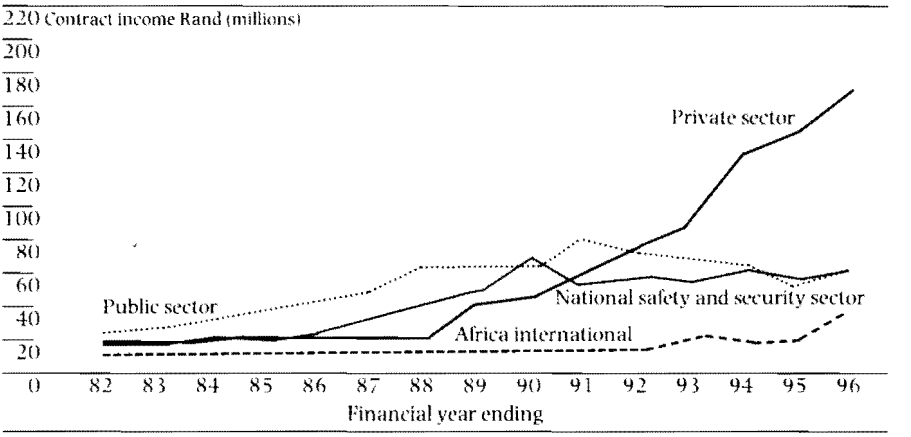
The results of the survey gave a clear message that those sectors previously neglected by the CSIR strongly acknowledged the role of science and technology in the development of the nation with the emphasis predominantly on its practical application in the areas of community upliftment, SMME development, in establishing a national science and technology culture, and in supporting big business – in that order. This view did not include the respondents representing big business. In view of the proposed Reconstruction and Development Programme, being drafted by the Government in waiting, it was a message that needed to be taken very seriously indeed. Its proponents knew and accepted that national, community and business leadership would be relying on the local science and technology community's information sources, knowledge and expertise.

At this stage there was a big gap between the emerging stakeholders and CSIR staff's perception of the priorities mentioned above as well as the future role of the CSIR. There was an inclination among staff towards more autonomy and increased independence from Government for the CSIR and particularly strong feelings about preserving the momentum of their traditional core business, while emerging stakeholders were awakening to the extent of the powerful asset available to them, its uniqueness on the African continent being an added bonus.

Respondents considered the nation as the key stakeholder to whom accountability was to be exercised through a legitimate, democratically elected government. Legitimacy was a particularly important issue. The CSIR had sought its legitimacy in the past in the Act of Parliament that spells out its mandate, and justifiably felt that it was doing a good job. But the organisation's technical legitimacy had never been in question. What was in question was its relevance. For emerging stakeholders the CSIR's legitimacy was vested in the composition of the Board and the workforce, its accountability to and co-operation with a democratically elected government, and its alignment with the objectives of the RDP.

Criteria for the future success of the CSIR were 'the appropriate use of

CSIR External Contract Income



public funds by competent leaders and staff to develop and apply technology specific to the needs of the full South African community'. The bottom line was that there would have to be a 'fundamental realignment of energy, resources and capacity from the strengths of the past to the opportunities of the future . . . the message (was) one of transform not reform'.

What was less clear was the exact form of the relationship between the future government and the CSIR, and the relative priority of the future role with big business. CSIR management rated competent leadership highly while the future government emphasised accountability and legitimacy. Eventual agreement on these issues was of vital national importance.

Any future strategy for the CSIR would have to include a programme to bring home to staff the importance of the CSIR's broader responsibility and the benefits inherent in its cultural diversity. Such a culture change would eventually surpass the magnitude of the previous transformation, which although revolutionary was still within the realm of a culturally familiar frame of reference. The second transformation involved dislodging deeply entrenched cultural beliefs and practices bred by a largely Western tradition and the legacy of apartheid.

By 1993 competence in strategic planning had matured sufficiently for the process to be revised. The rigid discipline of the annual planning procedure had certain drawbacks as it created a culture that planning happened only once a year and divisions often drew up plans for the Executive's benefit rather than for practical implementation.

To emphasise the importance of the actual implementation following the usually meticulous planning part, the annual planning procedure was transformed into an ongoing activity. The new approach forced line management

to be ever alert to threats and opportunities in the marketplace and to respond promptly to these changes. A culture of dynamic strategic thinking was reinforced so that managers would be sensitive to even the weakest signals suggesting future trends, emerging competition and the like.

The CSIR had by now developed sufficient balance to accommodate a drop in a particular market sector and to develop new sectors. This hard-won flexibility was well timed. The communication revolution has ensured that, even if only marginally, no power would be left untouched by the globalisation of business. The current political developments too would test this professed flexibility to its limits. The ability to adapt in response to the demands of the times, preferably proactively, could determine an organisation's survival or demise.

The Board advised management to focus on fewer key issues and to increase the emphasis on outputs now that they were comfortable with strategic processes. In short, management began to move away from the textbook approach. In future, extensive use would be made of externally available scenarios, using costly manpower to concentrate on technology-specific scenarios. Not only would these professional views help shape internal policies and strategies but could also be used to assist industry and government.

The IDRC study, the CSIR's participation in the STI and the insights provided by the comprehensive survey of its stakeholders and staff directed the CSIR's new strategic initiatives to set in motion its second major transformation. When the CSIR embarked on its revolutionary course in 1985, no one could have predicted the chain of events that would change the face and very fabric of the country: the demise of the Soviet Union, the fall of the Berlin Wall, the pressures that brought the National Party to its knees and apologising for the sins of apartheid, and the freeing of Mandela with the promise of the birth of a new democracy.

These developments triggered the revision of the science and technology priorities and opened up new growth areas and opportunities to be utilised. The CSIR had to build on its strengths in assisting big industry and greatly expand its services to the small, medium and micro-enterprises and communities. Underpinning and linking both these drives was the technology to enhance quality decision-taking.

PLOTTING THE COURSE

In moving away from cyclical strategic planning, it was essential that the vision, mission and corporate strategy would properly capture and define the overall organisation direction in the CSIR's five-year plan issued at the end of 1993. Where the term 'relevance' was narrowly interpreted seven

years previously as being in touch with the needs of industry, the updated vision clearly took cognisance of the wider technological needs of the country, namely to grow the CSIR's contribution to the new South Africa through technology for development and for creating jobs and prosperity.

Massive reconstruction of the country was on the cards. To reduce the wealth gap would require high levels of economic growth. A sound technological infrastructure in this scenario was an agreed precondition for boosting both economic growth and support for community development. Tools to support decision-taking would also be required in, for example, land allocation or reallocation, and in accessing appropriate technologies.[2]

Thanks to its previous transformation, the CSIR was in good shape to respond to the changing needs of the market place. Adjusting its course had become part of the continuous management process and the actions required to launch a second transformation are being implemented with little demur. The opportunities opening up in the process are proving to be so exciting that the revolution is experienced rather as a logical evolutionary process and therefore much easier to manage. It is tangible proof of how much the CSIR had matured. However, the full impact of the adjustment and culture change would only unfold gradually as the effect of the strategic initiatives gained momentum.

The big challenge lay not so much in the technological sphere but in establishing working relationships with the new stakeholders and in developing an appropriate balance between the main strategic thrusts. Doing justice to the neglected smaller business sectors and infrastructural needs of the communities, without neglecting the needs of big business, and promoting the rightful role of blacks and women in the organisation would require an adjustment of priorities and of power relationships. The main technological avenues the CSIR would follow to meet these challenges and to achieve its goals were summarised as:

Technology for Competitiveness – being the technology partner of industry in both the formal and informal sectors to promote economic growth;

Technology for Decision-making – providing science and technology support to enhance decision-making in the public and private sectors;

Technology for Development – providing technology solutions to improve the quality of life in urban and rural communities.

Although in alphabetical order, the order of these thrusts may well have been determined by their relative contribution to the CSIR's business and probably by comfort zone considerations. It would soon become apparent that none could be neglected at the expense of any other.

PRIMARY DESTINATIONS

Having identified the major challenges facing the CSIR and the broad direction it was to pursue to fulfil its role as a technology provider in the new South Africa, specific longer-term goals were set to give substance to the vision. The management team identified existing approaches or mechanisms requiring either reinforcement or adjustment, namely the concept of technology partnership, science and technology for emerging needs, the CSIR's international role and the necessity for focus and integration.

The concept of partnership with industry and other interest groups was formulated in the late 1980s to serve as a slogan and a cornerstone of the new CSIR's philosophy. It has proved to be the foundation of the way the CSIR does its business. Where the old CSIR had strayed more and more towards own-choice research, this practice was surgically removed and replaced with the current approach of aligning the organisation with national and market priorities. Partnership implies long-term relationships and trust. The CSIR had changed and needed to build credibility. The basic strategy proved to be sound, but the partnership had to be extended to a wider range of technological endeavours, from big industry to the fast-growing micro-enterprise sector.

The scope of the partnership approach includes alliances, in which the CSIR enters into an agreement to become the research arm of a big organisation, or a joint venture in which either party acts as the instigator seeking complementary skills from the other. The multiple nature implicit in this approach requires a delicate balancing act, in which ethics is of prime importance. The CSIR contributes technical leadership and technical authority and is sometimes called upon to be both player and referee. Financial gain is not necessarily always the measure of success, but also the degree to which the CSIR has helped the partner in achieving its goals.

When the slogan 'Your technology partner' was formulated, the CSIR had to ensure that it remained in touch with developments that could affect present and future partnerships.

One such vehicle was by conducting surveys, but up to the early 1990s this was done with the old South African perspective. The information from the industrial sector was highly valuable because the right questions were being asked. Although rural communities were surveyed, the quality of the information was limited by the CSIR's ability to interact with them. The staff composition since has steadily changed to include more people who understand the process of establishing the real needs of the communities. The findings of the IDRC study provided further insights which helped the CSIR to align its strategy with the demands of its environment.

The formal sector of the economy requires technology, supporting products, processes or services, to boost its bid for global competitiveness. This has been the foundation of the CSIR's core business. The demands on the nation's resources are expected to exceed supply, and the CSIR is exceptionally well placed to supply the tools to support quality decision-taking. As part of its efforts to step up its support to small, medium and micro-enterprises and providing technology for urban and rural communities, the CSIR has already chalked up a number of successes in helping small entrepreneurs with establishing, for example, chicken abattoirs, rural bakeries, atchar production operations, small-scale saw milling operations, water systems for individual houses and house-building techniques right down at the community level. By establishing contact with developing powers in other parts of the world, the CSIR is gaining the benefit of their development experience to apply locally.

Working with the public sector in the past had occurred mainly at the national level. In the new dispensation decision-making power is being relegated to lower and lower levels and the CSIR is dealing with government layers from local, to metropolitan, provincial and national structures. This increased exposure to infrastructural needs is mutually beneficial and will broaden the CSIR's ability to provide for the country's technological needs and contribute in a more informed manner to the national science and technology policy.

Having worked at all levels of the technology spectrum over the past few years, the CSIR has found that the problems encountered are not markedly different. When technology, high or low, is transferred, the technology provider has to ensure that the process runs smoothly in its particular environment. It must do so reliably and repeatedly, the ultimate aim being that the technology user will profit from it and that jobs are created in the process.

The CSIR aims to entrench its role as the leading force for science and technology on the African continent. In implementing its technology transfer strategy, the CSIR extended the scope of this function by utilising existing technology imported from abroad, adapting it to African needs and providing the support for its successful implementation.

International relations before the eventual democratising of the country were limited, influenced both by the international campaign of isolation and the CSIR's traditional bias. In the past international contact was confined to its research and development counterparts, government agencies and networks of contacts between individuals in scientific research systems.

From the period directly preceding the 1994 elections the scene changed

dramatically. The emergence from this dark era considerably extended the scope of the CSIR's international relations. The immediate effect was that the CSIR became less Eurocentric. While retaining and strengthening its Western contacts, the focus has increased strongly to include Africa, Asia and South America. The purpose of the contact is both to seek new sources of technology and to find new markets, which could result in concluding co-operative agreements and international contracting. These advantages are offset by the increased competition the CSIR can expect from international consultants and contract research counterparts moving into the new South Africa.

The CSIR can only compete internationally by selecting highly specialised niche markets. It is already supplying products and services to countries in Africa, the Middle East, the USA, the Republic of China and several European countries.

Although the CSIR has been active and successful in Africa from its early years, its involvement was strictly reactive. Since the 1994 elections, collaborative projects have escalated, the CSIR being currently involved in some 20 African countries. Among them are Malawi, Kenya, Mauritius, Seychelles, Botswana, Congo, Zambia, Lesotho, Swaziland, Namibia, Zimbabwe, Mozambique and Angola. The enterprises include infrastructural technology (transport, telecommunications, water and sanitation, construction), environmental technology (impact studies, management and information systems), urban and rural development (affordable housing, primary health care, small business development), agriculture-related (forestry, food processing, animal feeds), and energy-related (solar energy, waste management). These activities are growing at a tremendous rate.

With its wide range of technology capabilities the CSIR can assemble integrative teams to tackle complex multidisciplinary problems. This capability is the biggest differentiating feature of the organisation, but the advantage has not been harnessed to the full. Made up of autonomous business units, the CSIR encounters the same stumbling block as other corporations with a federal structure. The problem lies in 'the complex managerial task of reaching for the benefits of both local autonomy and collaborative action'.[3]

To cope with this dilemma the CSIR launched a thorough investigation to identify the barriers to better collaboration and the incentives required to promote a more integrated approach. The starting point for any effective integration proved to be market pull, identifying an appropriate need that requires multiple inputs. The second requirement was to adapt the reward system. Bottom-line considerations, concerns about meeting sales targets and short-term thinking combine to discourage collaborative actions.

Management's intention is not to manage by bottom line, but if performance is evaluated by a programme's ability to meet individual sales targets only, integrative behaviour will be discouraged.

Forces outside the CSIR are helping to speed up the integrative drive. Big companies are approaching the CSIR of their own accord to assist with multidisciplinary research projects, and as the RDP is deployed opportunities are emerging to address multiple infrastructural needs in a co-ordinated manner. Expansion of the CSIR's Technology for Development programme locally and the increased contact with African countries are stimulating closer co-operation between divisions for the simple reason that it makes good business sense. The St Lucia environmental assessment project, in which five disciplines from four divisions and several subcontractors outside the CSIR collaborated, was a prime example of what could be achieved. Co-ordinating initiatives are in the pipeline for other market sectors such as health, tourism and rural energy.

Constant maintenance of the electronic databases with information on available expertise, contracts, patents, client liaison and relevant marketing matters also helps to support a co-ordinated approach. Ready access to such information serves to reduce duplication of work and conflicts of interest with shared clients.

EN ROUTE

With these longer-term ends in mind, the CSIR could concentrate its energy on hands-on action. It logically had to build on the strength of its traditional core business of assisting industry in gaining a competitive edge and optimising its decision-support capability. The largely uncharted territories of technology for development and affirmative action would require a special effort. Furthermore, the demands of the market place were focusing increased attention on quality, adding yet another facet to the changing culture. Lastly, the CSIR had made much of the value of being people-oriented, but so much effort had gone into establishing a new culture that management had not done enough to develop and nurture its human resources.

Mindful of the considerable nudge it had received from the future decision-takers, the CSIR assessed its track record in areas other than big business. Since its inception, it had given limited technological assistance to both urban and rural communities. Sporadic support for owners and managers of SMMEs also occurred over many years. These activities, however, were of an ad hoc, reactive nature and were insufficient to meet the real needs of the country, a fact that was severely criticised in the IDRC study.

To expand its service to these sectors the Technology for Communities

activity was transformed into an extensive Technology for Development Programme, answerable to the Executive Management Board, with an executive vice-president devoted exclusively to its development and deployment. New mechanisms had to be developed to ensure effective co-ordination of the organisation's wide range of relevant activities. The programme commits the entire organisation to make its expertise accessible to the communities and contribute to improving the quality of life of all South Africans.

An extensive network was set up to monitor existing and emerging needs in urban and rural communities to support the social reconstruction and economic empowerment aspects of the RDP. In the mid-1980s the CSIR had started employing social scientists in both the fields of water and building technology to assist researchers in interacting with the communities. More social scientists were gradually employed to assist with developing community-based structures, mobilising of communities and, in this interactive way, identifying their most pressing needs.

The CSIR makes formal proposals of the intended technological solutions to the communities for their review and approval. If positive, social scientists assist the community leaders to obtain funding for the projects. Not being a funding agency, the CSIR operates on a client/contractor basis. The delivery of these services adheres to strict project management principles with continued community participation throughout the process. A growing percentage of the Parliamentary grant is voted to improve the CSIR's ability to serve the development sector.

This approach to providing technology support to the communities is also aimed at linking social upliftment activities with the enterprises within a given community. Whenever new micro-industries have been launched or training courses offered, the CSIR provides follow-up support as part of the service to ensure that initiatives are sustained and possible environmental effects monitored. The whole drive is geared to optimise job creation and retain the income within the community.

The CSIR became an active member of the National SMME Initiative, enabling it to improve and expand its technological services to SMMEs in both the formal and informal sectors of the economy. These services are channelled through local business service centres and manufacturing technology centres. They include technology procurement and transfer; technical support and training; implementing systems to improve competitiveness such as quality, cost-effectiveness and productivity; and management of information requirements.

The establishment of these centres is one of the most exciting current developments. They provide overseas funding agencies with a viable vehicle

for economic upliftment and, if managed correctly, could revolutionise the South African economy to fulfil the promise inherent in the vitality of the 'rainbow nation'. These centres are destined to form the necessary link between technology for development and technology for competitiveness, forming a continuum of small enterprises feeding bigger companies, a mechanism that has worked so well for industries in East Asia.

The CSIR also collaborates with the Small Business Development Agency, established under the auspices of the Department of Trade and Industry, in setting up an institutional framework to support SMMEs across the country. As these structures take shape, the CSIR seconds suitably qualified CSIR staff to assist the agency in fulfilling its mandate.

Most of the CSIR's facilities are situated in Gauteng with regional presences previously restricted to the Eastern Cape, Western Cape, KwaZulu/Natal and Mpumalanga (former Eastern Transvaal). These are clearly inadequate to support the decision-makers in all the provincial and local government structures, and appropriately qualified regional development managers are being appointed and deployed in the capitals of the nine provinces. They act as a link between Government and the CSIR and assist with need identification, the formulation of project proposals and the execution of projects. They also serve on government structures such as RDP commissions to help identify policy support requirements, linking appropriate CSIR staff to the resulting initiatives.

At the national level the CSIR assists with formulating white papers affecting the country's science and technology infrastructure and culture. It assisted the central RDP office in defining business processes to ensure coherent implementation of the presidential lead programmes. A senior management official, Mr Roy Page-Shipp, Director of Corporate Special Projects, was the first to be seconded to operate out of the central RDP office in November 1994.

To facilitate rapid two-way contact with Parliament, the CSIR has set up an office in Cape Town to give decision-makers direct access to information on science and technology resources and policy matters. Ms Berénice Lue was tasked with establishing the service and to promote the role of science and technology in national decision-taking. The office also houses the regional development manager. This initiative is supported by a rolling contact campaign to familiarise government decision-takers at all levels with the CSIR's ability to provide science and technology support. Groups of officials are invited to the CSIR to attend presentations and demonstrations of its expertise and services.

The CSIR is playing a leading role in formulating a science and technology policy to support the RDP in its task. Among others it helped to establish

a national framework to co-ordinate the activities aimed at promoting technology for development countrywide. Thus the activities of the CSIR's Technology for Development Programme form an integral part of the national effort in this respect.

Although the primary focus of the CSIR is on the social reconstruction and economic development of South Africa, it has extended its activities into sub-Saharan Africa and the Indian Ocean Commission. The CSIR's policy is to support the implementation of the RDP wherever it can promote regional development.

Initiatives born out of the Technology for Development drive may be breaking new ground and, if successful, the CSIR could in future export such technologies to other developing communities in Africa and elsewhere.

As technology dominates almost every aspect of our daily lives, its failure causes us anything from acute discomfort and huge financial losses to, worst of all, loss of life. Many modern-day disasters can at least be minimised, if not eliminated, by proper management for quality. Our dependence on good technology apart, managing for quality makes good business sense by increasing the suppliers' ability to satisfy client needs and by reducing production costs.

Quality involves a continuous process of improvement. In the old CSIR the quest for improvement was carried out without a framework of principles. A steadily increasing volume of contract research brought home to the CSIR the concept of quality in the market place as quality-conscious clients demanded results that satisfied their needs. Since the restructuring, management has made a conscious effort to introduce quality principles into the organisation, such as its strategic review in 1986, adopting the task group approach to problem-solving and planning, introducing the concepts of market and customer orientation, benchmarking and regular monitoring of its customers' opinions, and staff training programmes. What was still needed was a properly defined framework within which it could go about optimising its business in a systematic and co-ordinated way. As part of the new strategy, management introduced the concept of total quality management (TQM), which included adopting a set of quality goals to guide the CSIR on the quality leg of its journey.

Management identified suitable staff for intensive training by the US-based Juran Institute, selected because its approach was compatible with a technology-based organisation. The CSIR adopted an incremental approach and singled out three divisions to pioneer the process. Being a systematic approach to arrive at best practices, TQM is a process familiar to scientists. The logic inherent in optimising and standardising its practices was eloquently underlined by a study on the cost of poor quality.

The CSIR had for some time been involved on a small scale in helping small and medium-sized enterprises with implementing ISO 9000, which is an optional component of TQM. It usually involves a manual describing what various processes in a given environment should look like. As a contract research organisation, the CSIR itself requires quality management systems. However, there is no international standard system available applying specifically to such organisations. The principles inherent in ISO 9000 need to be extracted and customised systems developed for the CSIR. By 1998 all the divisions should have experienced at least some of the benefits of the quality initiatives.

The quest for continuous improvement is never-ending. Managing for quality forms an integral part of the organisation's fabric and culture. Formalising the process has only recently found its way into research organisations, and the CSIR has embarked on a great deal of pioneering work. The ultimate goal is that TQM will eventually become invisible, and that staff's behaviour will have changed to the extent that actions designed to achieve quality are routine, resulting in a culture that assumes there is no other way of doing things.

As a government-funded organisation the CSIR was bound by the laws of two previous successive governments in its appointment of staff and in maintaining segregated facilities. If blacks, Indians or coloureds were appointed it was almost invariably as administrative support or as labourers. That its scientific staff complement did not reflect the composition of the populace in the past, or even at present, must be the result of the education policy of the time, the obstructive racial legislation and the social attitude of discouraging women to take up scientific careers. Bantu education created an effective barrier for scientific talent to develop among the black population, not only because of the policy but also because the resistance movement started exploiting education for political purposes during the final stages of the struggle for equality. In the CSIR many administrative and menial jobs were available to black males only. The situation has noticeably improved since then, for both women and blacks. During the early 1980s top management started challenging these discriminatory practices by desegregating all amenities and social functions.

As the various population groups had literally led separate lives, entrenched beliefs, stereotypes and traditional practices were difficult to discard. Blacks experienced these so-called enlightened measures with mixed feelings. One of the first black researchers to be appointed at the CSIR, Mr Gcinikaya (Kaya) Mpepo, in 1983, experienced no problems from his immediate colleagues, but sensed that others, even blacks, avoided joining him in the tea-room. Ultraconservative whites resisted the removal of dis-

criminatory practices with either overt hostility or by avoiding contact as far as possible. For a while the good intentions almost backfired because discriminatory behaviour was brought out into the open and racial attitudes seemed to harden. Mpepo did not allow the negative aspects of his environment to stand in his way and has made solid progress in the CSIR. He has worked as a researcher in the fields of electron microscopy, corrosion, ceramics and, for the past two years co-ordinated the technology for development activities of the Division of Materials Science and Technology – one of the largest divisions in the CSIR.

By the mid-1980s an equal opportunity policy was introduced but produced disappointing results for several reasons. The education system did not yield many black scientists and engineers, and traditional attitudes still influenced women's career choices. In an effort to attract black students as potential employees, the CSIR supported students of the Leadership Education and Advancement Foundation (LEAF) with the idea of providing tertiary education bursaries for prospective science students. After four years and a very substantial investment, not a single student had opted for a CSIR bursary in science. The sponsorship was redirected to assist the children of black CSIR employees in their studies. This trend was further strengthened by the creation of an in-house adult education centre, offering courses from literacy training to the completion of matric.

Before this development and despite the prevailing discriminatory practices some black employees managed to beat the system and carve out a career for themselves. Among the most dramatic of these is the career of Philip Masemola who joined the CSIR in 1961 as a messenger with a Std 6 certificate. His inherent leadership qualities marked him for greater responsibility and for many years he successfully represented black interests in the CSIR. Today, with a matriculation certificate and a tertiary diploma to his name, he is part of the corporate human resource management team, one of the trustees of the CSIR Pension Fund and an honorary lifelong member of the CSIR Club, in recognition of some 30 years of service in successive social associations – an honour extended to only a few people. He remembers active discrimination at the CSIR in the past with regret, not being allowed on the soccer field or leaving the premises without a letter, among other absurdities. No wonder it took a great deal of courage for existing black employees to overcome the barriers of the past without experiencing acute discomfort, bitterness and resentment, feelings that have not entirely disappeared.

Management had formulated the equal opportunity policy in the old mindset, expecting divisions to take responsibility for implementing the initiative without demanding action plans or applying any form of pressure. Al-

though divisional management agreed with the basic philosophy, it was either paralysed by entrenched racial prejudice or simply avoided the unknown.

Because of the high demand for the limited number of black scientists and engineers, a countrywide pattern of high mobility has emerged. Many of them stay for no more than six to nine months or at the utmost two years. Given, moreover, that the CSIR had been perceived by the black public as an instrument to prop up apartheid, the organisation clearly had to do something to improve the situation.

Along with all the other revolutionary measures in its 1993 strategy, the Executive switched to the more aggressive policy of affirmative action. Management also realised that measures had to be taken to bridge the gap between the many culturally diverse groups. A comprehensive programme, which came to be known as *Sekunjalo*, meaning 'now is the time', was launched as a first step in creating awareness of the problems and advantages inherent in cultural diversity. The programme gave all employees the opportunity to air their views on what they understood by affirmative action and how they felt about it. People were encouraged to speak their minds 'without fear of retribution'. A facilitator acted as referee, while deliberately provoking intense debate.

Over a period of nine months about 99% of staff, in groups of about 100 at a time, attended the two-day programme. The majority of employees entered the process with negative perceptions, ranging from fears that the CSIR was going to be flooded with token black appointments at the expense of white employees to intense distrust of the Executive's motives and disbelief in whites' ability to adapt. Contact with competent black staff who insisted on being judged on merit and with whites who genuinely wanted to put discrimination behind them went a long way to allay the fears and sobered up many a fire-eater. A general willingness to learn more about each other was evident. People were encouraged to express their perceptions about black or female bosses, and once again competence was the key to acceptance. Staff came to realise that affirmative action had to do not only with black or female appointments but also with overcoming traditional attitudes. In the final analysis a member of the radical right wing was as much a victim of apartheid as his disadvantaged counterpart. Both had basically been deprived of a balanced education and accurate information – a practice that was moreover sanctioned by law.

Sekunjalo was an introductory process to promote a clear understanding of what affirmative action was. People had to realise that it could never be implemented successfully if it was done to appease a white social conscience or to ensure that blacks felt comfortable working at the CSIR.

to patronise them so they would keep quiet. Employees had to gain an understanding of the forces at work and how to deal with them, to accept cultural differences and to work out a common basis for co-operation. There is no existing blueprint and progress is bound to be slow.

Following *Sekunjalo*, divisions were tasked to embark on a continuous programme to promote the culture change. Divisions have unique needs requiring customised action plans to achieve the desired result in their environment. The involvement of the people in planning the initiatives that will affect their lives is essential. This division-specific approach must at the same time be balanced to achieve consistency throughout the organisation. Clear goals and the means to measure results are crucial for the success of the process. Leaders need to set the example and monitor the progress continuously.

As the programme is being implemented, the appropriateness of the label of 'affirmative action' is being questioned. Board member Dr Ivy Matsepe-Casaburri suggested the Afrikaans *regstellende aksie* to be used instead. The expression is considered to be more descriptive of the initiative, meaning 'taking action to set things right', whereas neither 'affirmative action' nor 'redress' implies positive action. A further argument was that its formal usage may help to depoliticise the Afrikaans language. While aiming at parity, *regstellende aksie* should make good business sense in the long term. The underlying philosophy is that for an organisation to operate at its best in its particular environment, its house should be in order. This drive can only be considered successful once the expression is rendered meaningless, when appointments and procedures can simply be measured against normal fair practice.

Initially, the people appointed in the *regstellende aksie* context are, and will be for some time to come, under severe pressure, because they have to prove to everybody that their appointments were made on merit, or, at least, that they have the potential to achieve with appropriate mentoring. Their success or failure will determine the level of remaining resistance.

Over the years women have made steady progress in the CSIR, without being militant, by the sheer force of their ability, demonstrating that equality is not a right to be granted but to be assumed. Even so they are still frustrated by a male-dominated culture, in which male leaders sometimes seem deaf to intelligent suggestions from the 'weaker sex', only to respond enthusiastically when the same proposal is put forward by a male member. Even worse is the exaggerated praise given to women for perfectly ordinary behaviour because it obviously exceeded the expectation of their ability to perform. This reaction pattern is widespread and also experienced by blacks in a white male-dominated environment.[4] It is most probably not

a conscious reaction, but the product of generations of conditioning, resulting in an established custom to tune out to people of whom little is expected, much like a mother indulgently murmurs 'yes dear' to a child's inconsequential chatter.

The policy is to use natural attrition as the mechanism to improve the balance in staff composition, while setting percentage targets for new appointees and bursars-to-be from the previous disadvantaged groups. The expectation is that it will take the education system 10 to 15 years to produce black and female scientists and engineers in sufficient numbers to make a difference of any significance in the internal demographics. To help this process along the CSIR is increasingly becoming involved in supporting training programmes to promote a science and technology culture in the country. An outreach programme aimed at schools has been launched to this end.

Human resource managers have a key role in leading and maintaining the process of *regstellende aksie*. Consultants were used to get the process going, but their influence is limited because they do not belong to the organisation. For results to be forthcoming, human resource managers need to be suitably qualified and empowered to fulfil this pivotal function and also supported by a fully committed management team.

The organisation is currently grappling to cope with what amounts to virtually four culture changes simultaneously. With business-oriented behaviour barely under their belts, staff need to adapt to cultural diversity and gender equality, develop new approaches to implementing technology

when operating in the development field, and to condition themselves into quality-directed behaviour. A workforce faced with such a multiplicity of demands is bound to cry out for professional help and much tender loving care.

The function of human resource management, as traditionally practised by the CSIR, had not been high-profile. Tasks were mostly administrative such as assisting with recruitment and administering salaries. More and more professional skills are being incorporated to assist with strategic human resource planning, culture change, team building and career development. External consultants can fulfil these functions up to a point, but there is a great need to develop in-house specialists.

The introduction of strong management principles into the CSIR was long overdue, but may have caused the pendulum to swing a bit too far. Although sound business concepts demanding strict performance measurement, good project management and dedication to quality and delivery in general strengthened the organisation, this was often exacted in an almost punitive environment. Once these essential business practices had become part of the culture, management could devote its attention to adding substance to the professed value of being 'people-oriented' and give attention to career development and the general empowerment of staff. There is a need for appointing and developing leaders with strong people skills in addition to their good management skills and for achieving a balance between caring for the external customer and the often-neglected internal customer.

In a stable environment, systems tend to dominate and it is easy to require individuals to fit into the system. However, when the sequence of events becomes unpredictable, the change requirements increase dramatically and the organisation must rely on the ingenuity of its people to handle 'matters for which a routine response may not exist . . . to tap the most potent economic stimulus of all: *idea power*'.[5] The truism of people being an organisation's biggest asset demands more than lip service.

Training the workforce to handle new responsibilities was part of the change process embarked upon in the late 1980s. Of necessity the first phase was highly intensive until the new culture was well established, after which the Executive kept up the pressure to cultivate a culture of learning by ensuring that every employee would undergo at least three days of training per year.

Mindful of the principle that an organisation can only respond promptly to the demands of the environment if decision-taking is possible at the lowest management levels, the CSIR embarked on a special programmme in 1994 to empower first-line leaders and technical specialists. The idea is

to improve the overall performance of the organisation by ensuring that first-line leaders feel competent in performing their duties. The programme soon started spilling over to include staff in general and getting management involved to enable an integrated approach.

Training courses focus on individual performance needs and on leadership, interpersonal and professional skills. This is only a first step to alert staff to their own potential and their responsibility to develop it. This development, however, can only take place if management itself understands the concept of empowerment and creates the environment in which it can flourish. Good communication, both vertically and horizontally, is an essential component of the initiative if the organisation is to reap the full benefit from its investment.

An exciting new initiative, the Advanced Leadership Programme, was launched in 1995 aimed at developing top leadership talent. A pilot group of 14 people was selected with a bias for action, natural leadership ability and team-facilitating skills to undergo a highly customised and personalised programme. They were taken through a process of learning about themselves, learning from prominent leaders in and outside the organisation, and finally systematically exposed to areas beyond their traditional field of specialisation, among others, by being seconded to organisations outside the CSIR. This practice promotes personal career development and developing a more holistic understanding of the CSIR's business, encouraging co-operation and breaking down destructive competitive instincts.

As the CSIR matures as a business, it is progressing more and more towards an integrative management system. Each division is required to include a coherent human resources outline in its business plan, linked to the competency requirements necessary for its successful achievement. Key components include career development, management and competence training for leadership, succession plans, recruitment goals and linkages with the *regstellende aksie* programme.

The CSIR's gathering at the bosom of professional human resource practitioners is yet another manifestation of the emerging realisation that professional skills other than the purely scientific are required for the successful management of a technology-based organisation. The scientists' acknowledgement of their need to incorporate management, finance and marketing as disciplines in a research environment proved to be the thin end of the wedge. This was soon followed by their reliance on social scientists as part of the team when communicating with the communities. Finally, the recognition of human resource and communication practitioners as professionals in their own right and as equal partners is transforming the

technology management scene into a truly multidisciplinary force.

LAND AHOY

At the beginning of 1994 Dr Garrett had completed his one-year stint to oversee the integration of COMRO into the CSIR, and Dr Johann Fritz, Director of Manufacturing and Aeronautical Systems, was transferred to head the Division of Mining Technology based on his past experience in mining research.

Shortly afterwards the Executive commissioned an extensive review of the energy-related challenges facing South Africa in the foreseeable future to align the CSIR's response to the latest developments. The task group under leadership of Dr Garrett concluded that the priorities in research, development and implementation should be focused on energy for development, energy for economic growth and on the impact of energy-related activities on the environment.

The Department of Mineral and Energy Affairs had shifted its focus to concentrate on energy for development, resulting in a major reduction in funding to the Division of Energy Technology. Two of its major once-off contracts were drawing to a close. In addition, the Kloppersbos section, dealing with research and development work in explosions associated with dust and mining, had been transferred to the Division of Mining Technology. The remaining activities had limited potential for undertaking integrative big projects within the division under the prevailing circumstances. This was particularly ironic since the division had just won the Research and Development Category Award of Technology Top 100 the year before.

Since considerable energy-related research and development was being conducted in other divisions of the CSIR, the strategy best suited to the current situation was to allocate these remaining activities of Energy Technology to those divisions where the best synergy could be achieved, namely Manufacturing and Aeronautical Systems Technology and Materials Science and Technology. This became official in August 1994. For a while Mr Dieter Krueger, former Director of the division, co-ordinated the relevant activities across the CSIR, but gradually the main thrust of the CSIR's energy effort moved towards meeting the growing demand for the development of rural and renewable energy resources – an activity that logically belongs to the Technology for Development Programme.

After intense head-hunting it became clear that it was going to be no easy task to find someone tailor-made for leading the large and dynamic Division of Manufacturing and Aeronautical Systems Technology. Executive Vice-President Dr Daan Toerien was appointed to act as Director in June 1994 until such time as a suitable candidate could be found. The full-

time occupation of Mr Mike Groch with managing the Technology for Development Programme had necessitated his portfolio of Marketing and Business Development to be taken over by Executive Vice-President Finance, Albert Jordaan.

At the end of 1994 Mr Neo Moikangoa was appointed Associate Vice-President and started an intensive induction programme including attendance of a prestigious Harvard Leadership Course. In April 1995 he became Executive Vice-President, Technology for Development, leaving Groch to concentrate on promoting the CSIR's increased focus on SMMEs and commercialisation. A suitable manager had by then still not been identified to lead the Division of Manufacturing and Aeronautical Systems Technology, and Toerien was appointed to do the job full-time.

After prolonged negotiations, going back to 1992, the CSIR withdrew from the Associated Institutions Pension Fund and the Temporary Employees Pension Fund, shedding another of the remaining relics of civil service practice. The finalisation of all details was concluded in 1995 when the agreed amount was transferred to the CSIR Pension Fund. The CSIR had established its own fund, managed along private sector lines, in January 1993, after which all employees who joined the organisation automatically became members of the new fund. Other members were given the option to remain with their existing fund or transfer to the CSIR fund.

At the time of the CSIR's restructuring the Fishing Industry Research Institute (FIRI) had opted not to be incorporated in the new CSIR. In the meantime the institute had encountered increasing difficulties in managing fishing operations as well as maintaining a viable research activity. As it was important to preserve skills and a unique resource base, negotiations were started to work out the details of its remerging with the CSIR. Much the same considerations applied as with the merger with COMRO. The CSIR would gain from acquiring a strategically important research and development resource, which strongly complemented the activities of the Division of Food Science and Technology. At the same time FIRI would benefit from the professional contractual research and development management skills, access to a wide range of science and technology capabilities available within the CSIR, and much-reduced overhead costs resulting from the rationalisation. The merger became a reality in April 1995.

This date also hailed the end of an era as President Brian Clark resigned from the CSIR after 30 years of service to become the Managing Director and Chief Executive Officer of Telkom. Having started at the CSIR at the age of 16 as a laboratory assistant and risen rapidly through the ranks to become its youngest president, he had decided that the time was right to look for new challenges. Under his strong leadership, the CSIR had moved

rapidly to meet the challenges of its fast-changing environment. The leading role he played in the national science and technology arena enabled the CSIR to respond timeously to the opportunities inherent in the Reconstruction and Development Programme. More than anyone else he was responsible for transforming the CSIR into a contract research organisation and relaunching it to become the immense national asset it was meant to be.

Soon afterwards the Executive Vice-President Human Resources, Mr Fred Camphor, also resigned to start his own business. This portfolio is being managed by Dr Adi Paterson, former Director of the Division of Materials Science and Technology, who also handles the CSIR interface with the Department of Arts, Culture, Science and Technology and oversees the investment of the Parliamentary grant. The Board's term of office was about to expire and the decision to appoint a new president was left until such time as Government appointed a new board. In the interim, the Board's term was extended and Dr Geoff Garrett was appointed as Acting President.

There is a strong emphasis on teamwork at executive level and members have their work cut out as the favourable response to the CSIR's strategic initiatives is fast gathering momentum. The new government has accepted the CSIR's technological leadership, and a good relationship is being forged which augurs well for the science and technology-based RDP initiatives. On the international front, the CSIR is being inundated with visitors from abroad investigating areas of co-operation and business opportunities.

The new Board was announced in November 1995. Four current members were retained, namely Mr Les Boyd, Deputy Chairman of the Anglo American Corporation, Dr Ivy Matsepe-Casaburri, Chairperson of the board of the SABC, Mr Eugene van As, Executive Chairman of Sappi Limited, and Dr Bill Venter, Executive Chairman of the Altron Group of Companies. The six newly appointed members are Prof Anton Eberhard, Head of the Energy for Development Research Centre at UCT, Dr Dhiro Gihwala, Director of the Peninsula Technikon's School of Science, Mr Khomotso Phihlela, Manufacturing Development Manager of Nampak Limited, Prof Friedel Sellschop, Deputy Vice-Chancellor (Research) of the University of the Witwatersrand, Ms Lyndall Shope-Mafole, Councillor of the Independent Broadcasting Authority, and Prof Errol Tyobeka, Head of Biochemistry and Acting Head of Research, University of the North. Dr Bill Venter was elected Chairman of the Board and Dr Geoff Garrett appointed President on 1 December 1995. Dr Petro Terblanche was appointed Director of the Division of Food Science and Technology – the first woman in the CSIR entrusted with such a high-profile decision-making responsibility.

This development ended months of speculation. The choice clearly emphasised continuity and a strong reinforcement of the mission and current strategic initiatives.

The past decade has been characterised by the unstable environment in which the CSIR had to conduct its business. It negotiated a radical structural transformation to acquire a business orientation in 1986/87, which took a major effort to get up and running. By 1992 this transformation was functionally complete. Events of historical importance were happening at a breathtaking pace and the CSIR was constantly making adjustments in response. The launching in 1993/94 of its second major transformation is steadily gaining momentum and is taking place without the extreme degree of anguish and turmoil that characterised the first event.

One of the most significant achievements of the CSIR has been its success in improving its income from the private sector. During the early 1990s this was a counter-trend achievement (*see* graph on page 86) as seen against the declining trend in the gross domestic product. This achievement has helped to offset the continuing decline in government investment in basic science and capacity-building research. By 1995 private sector income was by far the largest single budget component, being almost double that of government- and defence-commissioned research, which was traditionally the biggest component (*see* page 117).

As a technology provider, the CSIR does not only measure its success in terms of sales, but also by the gains resulting from the allocation of the Parliamentary grant, patents registered and contract reports, which for reasons of client confidentiality cannot be published. The number of technological innovations patented, both locally and abroad, has become a vitally important measure of the intellectual property the CSIR can provide to its clients. The number of refereed publications remains an important means of confirming scientific excellence. The number declined after 1987 as performance measurement criteria changed, but is again on the increase.

With the experience gained and the management talent and culture that had been developed, the CSIR feels confident of successfully handling whatever further changes and challenges the future may hold. The magnitude of the challenge to be instrumental in launching the new South Africa on the road to economic success is both humbling and exhilarating. The experience is adding another dimension to the understanding of the organisation as scientists realise the value of making highly relevant contributions to all levels of the technology spectrum, the value of incorporating contributions from other disciplines and professions to tackle the challenge, and the enormity of the gains to be had for the country. For once not only purely analytical skills are required, but the emotions are in-

CSIR STRUCTURE IN 1995

CSIR BOARD

PRESIDENT

VICE-PRESIDENTS

COMMERCIAL	FINANCE MARKETING	HUMAN RESOURCES	TECHNOLOGY FOR DEVELOPMENT

OPERATIONAL DIVISIONS

BUILDING TECHNOLOGY	MATERIALS SCIENCE AND TECHNOLOGY
COMMUNICATIONS AND INFORMATION NETWORKING TECHNOLOGY	MINING TECHNOLOGY
FOOD SCIENCE AND TECHNOLOGY	ROADS AND TRANSPORT TECHNOLOGY
INFORMATION SERVICES	TEXTILE TECHNOLOGY
MANUFACTURING AND AERONAUTICALSYSTEMS TECHNOLOGY	WATER, ENVIRONMENT AND FORESTRY TECHNOLOGY

volved as well.

Heartened by President Mandela's message to South Africa to 'go all out for growth' and inspired by the vision of what can be achieved when a nation is united to overcome great odds, for example by winning the Rugby World Cup and the African Nations Soccer Cup, the CSIR has embarked on an aggressive strategy for growth. The entire organisation's efforts are concentrated on providing technology for development, jobs and wealth creation. The message is: Grow the organisation, grow its contribution to all sectors of the economy and grow the prosperity of the nation. Be obsessed with customer satisfaction. Set 'killer' goals to stretch workers to the very limits of their ability, while supporting them with the means and rewards to do so. Live 'Your Technology Partner.' And whip up a winning attitude!

Beyond 2000

10

O that a man might know
The end of this day's business ere it come!

Shakespeare – *Julius Caesar*

Study the past, if you would divine the future.

Confucius – *Analects*

SCIENCE AND TECHNOLOGY – *QUO VADIS?*

In the previous political dispensation it was the responsibility of the Department of Trade and Industry to formulate technology policy. The department made various attempts over the years to devise a meaningful science and technology policy for the country, with substantial contributions from specialists such as the CSIR, but its efforts were often frustrated by the high turnover in ministers. The White Paper on an industrial development strategy, published in 1985, however, had a significant influence on the future direction of the CSIR.

To gain insight into international developments in science and technology policy-making, the CSIR commissioned a UK-based international consultancy[1] in 1991 to do a comprehensive overseas study. Armed with the findings the CSIR could adjust its strategy according to the latest trends. The study confirmed the importance of effective technology management in an innovative environment and achieving a proper balance between maintaining standard basic technologies without neglecting the advanced skills produced by fundamental research. The message was clear. The national research and development effort had to be directed at both these aims as well as at country-specific problems and opportunities to reap the benefit of investing in these technologies.

Recognising its responsibility to contribute to national science and tech-

nology policy, the CSIR renewed its efforts to become a leading contributor to the process. The very nature of the CSIR's business keeps it in close contact with the Department of Trade and Industry, its Minister and the Director-General, while regular meetings with other research councils make for better co-ordination of policies in the science and technology field.

The review of science and technology policy commissioned by the ANC, Cosatu and Sanco criticised the vacuum in leadership at ministerial level and the resulting policy vacuum. It highlighted the important needs to be addressed as set out in the previous chapter. In the past the Department of National Education had the responsibility for science and the major advisory body was the Scientific Advisory Council, which advised the Department on the allocation of the Parliamentary grant. The report levelled considerable criticism at both these bodies.

Following the study, the Science and Technology Initiative (STI) allowed South Africans of very different backgrounds to get together and engage in debates on science and technology issues of national importance. Participants had the opportunity to overcome long-standing cultural divides and established working relationships that are highly productive today. They realised that the new ministers of the Government of National Unity would be facing complex challenges, and in anticipation undertook studies on issues such as affirmative action in the science arena, governance of institutions like research science councils, and the science and technology system as a whole. The intention was not to be prescriptive but to provide quality information to serve as a basis for decision-taking.

Recognition of its importance was evidenced by former Minister Derek Keys's request for a formal linkage of the body with the National Economic Forum and by the German government's invitation to the STI to Germany. The visit provided much insight into what is involved in managing a research system in an internationally competitive environment.

Having served its initial purpose, the STI was disbanded at the request of Dr BS Ngubane, the current Minister of Arts, Culture, Science and Technology,[2] in favour of a more inclusive body, the National Science and Technology Forum, for which applications were invited countrywide early in 1995. Participants range from science and technology practitioners to beneficiaries including users of science and technology, funders and policy-makers, representatives of science disciplines and interest groupings. The function of this comprehensive body, covering the broad science and technology community, is to serve as a consultative forum on pertinent issues for the Ministry. Its purpose is to provide an integrated approach to science and technology within the framework of the RDP, to best serve the national economic, human and social development, and environmental

needs. Prof MW Makgoba[3] of the University of the Witwatersrand was elected as the first Chairman of the plenary, while Dr JH Temple[4] of Plescorp was elected Chairman of the working group, an executive committee which consists of representatives of the various constituencies.

The inclusion of science and technology in a senior government portfolio is an encouraging sign of the recognition of its value in decision-making. Dr Khotso Mokhele,[5] a Vice-President of FRD, observed recently in an address entitled *Whither Africa*:

> *All the post World War II examples of fairly rapid progression from underdevelopment to development have coherent Science and Technology policy and Human Resource Development strategies as invariable common denominators. More importantly, the apparatus that design these policies have had direct links to very senior individuals in government. In the most successful of the countries from which some of these examples emanate, the Head of State was directly involved . . .*

This is especially prevalent in the Pacific Rim countries that have made such giant strides in industry and the economy of late. South Africa was fortunate to enjoy Smuts's direct involvement in setting up the CSIR, only to lose this advantage in 1948. Smuts was the last Head of State in South Africa so closely involved with science and technology and so deeply committed to the principles underlying the CSIR's existence.

As the leading science and technology research organisation and a prominent member of the National Science and Technology Forum, the CSIR has the pleasant obligation to apply its learning to the benefit of the country, including active assistance in formulating national science and technology policy. The CSIR's basic research and engineering capacity built up over 50 years is significant, and the largest on the African continent. It also has 50 years of knowledge about how a research organisation functions and generates outputs under three different systems of government. It has gained valuable insights into what an effective relationship should be between the ultimate owner, namely government, the stakeholders and the management instruments that direct a research organisation to the benefit of the country's economy and all of its peoples. Over the last decade especially the CSIR has put a great deal of effort into acquiring the best information for managing organisations whose primary mission is innovation, research and creativity. These insights have prompted a comprehensive re-engineering of existing business processes and the introduction of entirely new processes, such as marketing, strategic management, technology and portfolio management.

The CSIR played a leading role in the working group which drafted South Africa's Green Paper on *Science and Technology* at the end of 1995,

the IDRC once again contributing to and facilitating the process. The paper was submitted to the nation for comments and suggestions, which the Department expects to set the tone of the enabling science, engineering and technology legislation in the years to come. The paper describes the issues and options to be considered in order to meet the range of economic and social challenges facing the country – to become more competitive and export-oriented, while taking care of basic issues of redress and social upliftment within the constraints of finite natural resources.

The approach to and practice of scientific research has changed over the years to adapt to the demands and pressures of the environment in which it operates. This process has been expertly analysed in the book, *Third Generation R&D*,[6] with the emphasis on the evolution experienced by Western research organisations.

According to the theory set out in the book, the CSIR was a so-called first-generation research and development organisation before its transformation in the 1980s, which essentially converted state funding into knowledge, selected its research projects on a fragmented, mostly ad hoc, basis, and did so without in-depth consultation with potential stakeholders and end users of the research outputs. This process has also been termed the 'strategy of hope',[7] a strategy according to which R&D managers would hire the brightest minds, create generous research budgets, locate laboratories in campus-like surroundings ('labs in the woods')[8], and hope that the researchers would come up with brilliant new products that would translate into revenue and national economic growth.

The evolution was from a strategy of hope to a more systematic approach where project management principles were being adopted, to the present continuous interactive process between research, management and implementation, termed third-generation research and development. Such organisations are marked by a well-defined mission for where they want to be in future, whom they want to serve, and what they want to offer with a clear understanding of the market dynamics within which they elect to operate. In response to its particular market dynamics, the CSIR supplies technology-intensive services or products that will address either market needs or opportunities, both in the short and longer term.

The technology management approach adopted is to *gain* the required technological competencies through a combination of sourcing, acquisition and in-house development. In the modern global technological domain, even leading technological players do not attempt to develop all required technologies in-house, usually described as 'reinventing the wheel'.

The CSIR then proceeds to design an appropriate portfolio of research projects around those technological competencies that can be developed

in-house. Great care is taken to balance such portfolios of research projects so as to minimise risk and maximise ultimate benefits. Return on investment in principle includes the extent of anticipated commercial or monetary returns, as well as expected longer-term social returns.

This third-generation approach to research and development management has been likened to a conversion of knowledge into wealth, whereas the first-generation approach was compared to a process of converting wealth into knowledge. The modern approach to research and development requires management based on modern business principles, without sacrificing the quality of the scientific or technological contribution. In fact, the CSIR introduced total quality management as a business process to ensure that all scientific and technological endeavours do in fact meet with the highest possible international standards.

One of the special challenges faced by the Executive Board is to manage the investment of Parliamentary funding. It is invested principally in support of competence-building research and development. Executive must ensure that the public funds so invested are in line with, and supportive of broader societal goals as defined in the RDP. This it does independently, as well as in close collaboration with, the relevant government authorities. The generation of knowledge is currently being addressed in a far more focused and responsible manner than before. The very essence of the CSIR's process of managing investment in product development is to build technological capital as researchers concentrate on the generation of intellectual property. The seriousness with which the Parliamentary grant is managed today far outstrips any such approach in the past (*see* graph overleaf).

Critics of the CSIR's radical change in the 1980s feared that it would be living off its technological capital and eroding its knowledge base. This view is partly based on the incorrect assumption that everything the CSIR did during its first 40 years was perfectly planned to be of relevance. Science in isolation has been widely rejected by authoritative thinkers the world over today, not for ideological reasons but because it did not deliver. The 'labs in the woods' mandate was too narrow and world economies could no longer afford the concept of unfettered research. The successful industrial countries of East Asia had no tradition of basic research. South Africa today may be compared with these countries as they were 50 years ago. They used the available knowledge and built up a competitive edge in managing its implementation, and optimising production processes and product quality. Thus, the CSIR moved away from a culture that valued science-based, curiosity-driven research and individualism to a value system symbolised by technology-based, strategy-driven research portfolios and the team approach. It was a transformation from an inwardly focused self-serving

Allocation of Parliamentary grant 1993–1996

R'000	1993/94	1994/95	1995/96
Technology for competitiveness	71 012 31,5%	76 678 34,6%	70 688 30,1%
Technology for development	17 883 7,9%	30 653 13,8%	53 679 22,9%
Technology for decision-making	62 581 27,8%	56 353 25,4%	50 553 21,5%
Regstelende aksie	4 084 1,8%	7 338 3,3%	9 464 4,0%
Strategic implementation*	66 234 29,4%	44 116 19,9%	48 124 20,5%
SEED**	3 148 1,3%	6 382 2,8%	1 732 0,7%
Total	224 942	221 520	234 240

*Includes for example: quality, empowerment of staff, and core corporate and organisational shared resources **SEED = exploratory concept evaluation

ethos to one that is externally focused, market- and customer-orientated[9].

Following its mandate of assisting in the development of research talent, the CSIR was regarded as a training ground for young researchers. It now competes with others for this role and presents a different school for maturation than previously. Young graduates are confronted with contract research and have to develop project management and business skills along with the acquisition of research experience. Specialisation in a particular field must be supplemented with a range of multidisciplinary skills in order to make the graduates marketable and to deal with the demands of the RDP. The CSIR today puts equal emphasis on science, the market and technology.

The changing demands in the research environment of science councils and industry may require a reviewing of university curricula. This view is increasingly being supported by modern academics such as Dr Khotso Mokhele:

> *The thick walls that separate disciplines should fall to make way for complementarity between disciplines. As we construct a new nation in a new country, it is important that universities adopt curricula that allow for the creation of new graduates and diplomates. Transdisciplinarity ... or multidisciplinarity should become the new philosophy that must underpin the creation of the new graduate.*[10]

If researchers who came through the old CSIR are compared with the present generation after a five-year period at the CSIR, the latter are far better prepared to deal with the current demands of the country.

The CSIR's business requires a proper mix of specialists and generalists. All young researchers bring a set of specialised skills to the workplace, but it is their responsibility to ensure that they build additional skills and are

flexible enough to adapt to changing future demands or face unemployment. Innovators are usually characterised by being able to draw on a wider frame of reference than their colleagues. This ability enables them to see a wider range of permutations and combinations.

The first transformation brought the pressures of the commercial world into the CSIR. Some researchers feared that an innovative organisation could not live on its nerves. However, a stable environment is not necessarily a prerequisite for innovation. The host of accelerated inventions that occur under pressure of war is ample proof of this. History has shown that the old aphorism of necessity being the mother of invention still holds true.

The Western approach to research in the 1950s was for each country to do its own research and development. In the current global economy, the trade in intellectual property has assumed great importance. The nation state cannot afford to rely on investing in its own research and development only, but has to extract the maximum benefit from the intellectual property available in the world. The differentiating factor may well be the rate at which the country can put the knowledge to practical use. The Director of the US National Science Foundation, Erich Bloch, said recently: 'The emergence of the global economy means that a nation's competitiveness is now determined not so much by the availability of natural resources as by its ability to generate and deploy new knowledge.'

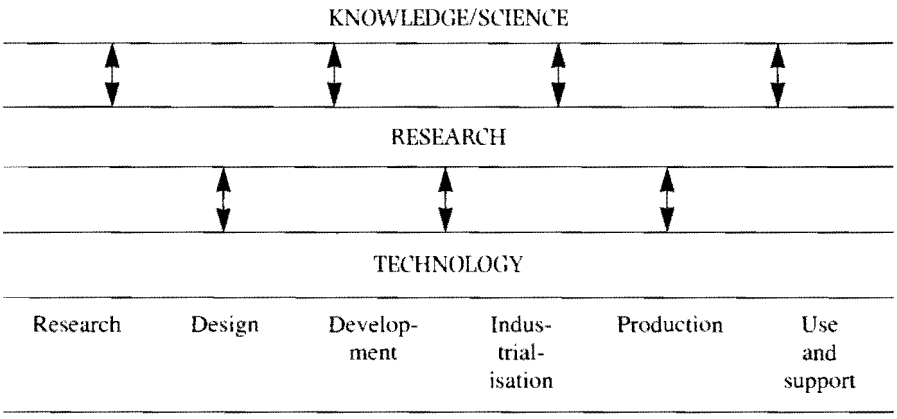
The customary division of science into basic versus applied research is becoming irrelevant. In the West, the science and technology community tended to equate science with research and saw research as a prerequisite for product development.[11] The current thinking is that research is a process to gain knowledge and, although correct to have it as the first element in the product life cycle, there is another approach to consider. Research is also used to obtain knowledge about all the other technologies involved in the rest of the product life cycle and can therefore be introduced at any point in the process (*see* graph overleaf).[12]

The decisive factor is what is done with the invention, the end product, namely the effective application of the knowledge involved, the so-called intellectual property. South Africa's per capita income puts it in the third world category and as such requires a pragmatic approach to research, concentrating its efforts on innovative ways to solve its real problems and striving to keep a balance between pragmatic short-term and strategic long-term financial gains.

THE FUTURE

The role of science and technology in underpinning the national economy is widely accepted. The Department of Arts, Culture, Science and

Science, research and the product life cycle



Technology and its stakeholder consultation body, the National Science and Technology Forum, are evidence of government's appreciation of its importance. The revision of school curricula also shows promise of increasing the emphasis on technologically and practically related subjects.

An enormous challenge facing the science and technology community stems from the need to overcome the shortcomings of the educational infrastructure, another peculiar legacy of apartheid. Of much importance too for the current available research on human resources is to maximise co-operation, both locally and internationally, to make the most of the country's limited technological resources and to overcome the effects of the scientific community's prolonged isolation from the latest technological developments.

Despite these negative circumstances, the country possesses skills that are truly world class. The South African science and technology system has centres of excellence to build on such as electronics, software engineering, materials science and technology, biotechnology, aspects of mineral processing, and in the area of mining technology, among many others.

Research and development institutions in South Africa tended to serve a limited section of the population in the past. Their technology resources have been predominantly white and male. These demographics need to be transformed to become more representative of and accountable to the South African people. The goals of the science and technology system need to be redefined and aligned to national priorities.

Although the present system in South Africa performs more than 50% of the research and development done on the African continent (UNESCO 1989), it is only a small fraction of the worldwide effort and even smaller than that of many private sector companies in other countries. South

Africa's total research and development expenditure (private and public sectors) in 1991/92 amounted to about R2,8 billion, or in dollar terms $1,01 billion, and remained roughly the same for the next two years, compared with for example that of companies like General Motors' $5,9 billion, Siemens' $5,3 billion and Hitachi's $3,9 billion in 1993.[13]

The White Paper on the *Reconstruction and Development Programme* set out the national goals in the industrial and economic context, but left the translation of these goals into practical implementation to executive government, the private sector and the community at large. The strengths, constraints and weaknesses of our socio-technological base will determine what is feasible now and in the future.

The South African economy has been built on the advantages offered by abundant raw materials, such as gold, diamonds, coal, chromium and iron, along with a strong agricultural sector providing adequate food for the local population and exports including wool, hides, sugar, maize, fruit and fruit derivatives. Exports of commodities have allowed South Africa to import capital and consumer goods, creating a fairly open economy. South Africa's dilemma is that its raw materials form the biggest percentage of its exports and that market is declining, whereas it has only a negligible share in the growing market for secondary products.

Clearly the country's efforts and research and development funding should be directed at boosting its share in expanding markets. During the period from 1984 to 1990, research and development expenditure in South Africa declined in real terms by some 3% per annum, at a time when the world was experiencing a real increase in this type of expenditure of approximately 3% per annum.

One of the main challenges facing the new government is creating an environment in which science and technology can flourish. Only then can science and technology make its rightful contribution to achieving national societal goals, in particular sustainable economic growth, social equity and quality of life, and environmental protection.[14]

The experience gained internationally about the role of science and technology in promoting economic growth and quality of life cannot simply be transferred piecemeal and applied to the South African situation. Unique circumstances demand innovative solutions in addition to customising the available knowledge. Organisations like the CSIR are ideally placed to do just this and to provide home-grown solutions on its home ground.

The difficulties confronting the country are balanced by exciting and unique opportunities. In the African context, South Africa has the potential to be the choice place for companies to establish themselves, and for peo-

ple to live in order to do business in Africa. Potentially, South Africa is the gateway to Africa because it is at the interface of the first and third worlds and has the strongest economy south of the Sahara. The biggest percentage of the world's population live in developing countries, which may well represent the future growth market of the world rather than the stable zones. By focusing the country's brain power to understand the interface better, it could develop appropriate products, services and skills to create a strong growth market.

One such possibility is in the field of water technology. South Africa is an arid country and water is a major limiting factor in industry and in supplying basic services to communities. The local scientific workforce possesses exceptional skills in this field. By concentrating resources on the water problem, its conservation, purification and re-use, South Africa could develop technologies to export to the many other arid countries in the world.

Identifying the areas where South Africa could make a strong contribution holds great promise. The CSIR has thus far anticipated the occurrence of events with a high degree of accuracy. The strategies are in place to deal with the current realities. It has an infrastructure unique in Africa, with the capacity to develop solutions peculiar to our environment, thus bridging the gap between first and third world technologies. Already the pattern emerging from the various initiatives in technology for development points to small and micro-enterprises becoming building blocks for technology for competitiveness. As big companies unbundle and look for new opportunities, the inherent sense in becoming involved in linking a host of small enterprises with competitive business must be evident.

The CSIR has built its new culture to be responsive to the changing environment. It has built capacity in terms of management systems and organisational platforms. The learning it has acquired in resolving many of the strategic and managerial problems posed by its repositioning initiatives is at the disposal of all parties interested in promoting science and technology in South Africa. Because of its respect for the sheer diversity of the components that make up the South African science and technology system, the CSIR is under no illusion that the solutions it has devised can be applied with equal effectiveness in any part of it. The change process on which it embarked in 1986 and reinforced in 1993 is likely to retain a 'work-in-progress' pattern for the foreseeable future.

One of the dynamic components of the present South African scene is that of a changing approach to the working environment, where the value of contributing something supersedes the value of gaining something. It does not eliminate the profit motive, but relegates it to the second order. The appeal is to the values of people to want to make a difference.

This phenomenon is very prevalent among those South Africans who were engaged in the struggle to achieve democracy and are devoting their lives to building a new order, much like the Afrikaners did in the 1930s in order to build a nation. This enormous commitment is a very healthy and inspiring driving force.

The CSIR has wonderfully challenging opportunities for people. it is more flexible, more open, and offers more scope for young people today than ever before. If the lessons of the past are heeded, the CSIR is poised to grow its value as a national asset of enormous potential.

The technology odyssey that started two million years ago remains an exciting challenge as the technological horizon and man's capacity for innovation continue to expand. Hindsight is said to be an exact science, foresight an educated blessing.

Profiles of Presidents

Nothing great was ever achieved without enthusiasm.

Ralph Waldo Emerson – Essays, *Circles*

MARK OF A PRESIDENT

The centralisation of the functions of Chief Executive and Chairman of the Board that past CSIR Presidents enjoyed had the effect that they could determine the character of the organisation to a very large extent. The course of the CSIR was adjusted at each instance, to a greater or lesser degree, by the personal style and approach to research of the individual presidents.

Sir Basil Ferdinand Jamieson Schonland
CSIR President
1945–1950

Schonland was a very dynamic and strong-willed person. He loved a challenge and would probably not have taken the job of putting the CSIR to-

gether if he had not been given a free hand. He firmly believed that only one person should be in charge to get things done and was unperturbed if firm action made him unpopular. In short, he was a benevolent dictator who achieved the desired results.

His dynamic nature often translated into rapidly changing moods. He could switch at whim from the autocratic brigadier to the wise professor, the devoted researcher and the visionary President of the CSIR, much to the consternation of his staff who tried desperately to anticipate his moods. Once a difficult task had been accomplished, he became bored and started looking around for new challenges. Thus, he did not accept his appointment as an indefinite one and once the CSIR's machinery was running smoothly, he returned to the Bernard Price Institute. He originally intended to devote three years to this 'missionary task', but stayed for five.

He left his assistants with a final message, his favourite quotation: *Nihil illegitimi carborundum* or just NIC, as he referred to it. The translation: 'Never let the bastards grind you down!'[1]

Schonland was born in Grahamstown in 1896. He was awarded a BA (Hons) degree at Rhodes University and continued his studies at Cambridge. During World War I he served with the signals corps of the Royal Engineers. He was discharged with the rank of Major and Chief Instructor, Wireless Communications, having been decorated with the OBE (Mil) and mentioned twice in dispatches for bravery.

On returning to Cambridge he completed his natural science tripos and worked in the Cavendish Laboratory until 1922 when he was appointed Senior Lecturer in Physics at the University of Cape Town. He completed his research for a PhD from Cambridge and turned his attention increasingly to the study of lightning. In 1936 he was appointed Professor of Geophysics at the University of the Witwatersrand and became the first Director of the Bernard Price Institute of Geophysical Research which was officially opened in 1937. In 1938 he was elected a Fellow of the Royal Society for his work on a lightning discharge mechanism.

At the outbreak of World War II in 1939, General Smuts asked Dr Schonland to establish a special unit within the South African Corps of Signals for the development and application of radar. On secondment to the British Armed Forces, he became Superintendent of the Army Operational Research Group. With the rank of brigadier he became scientific adviser to General Montgomery in 1944 and was awarded the CBE (Mil) 'in recognition of gallant and distinguished service in the field'.

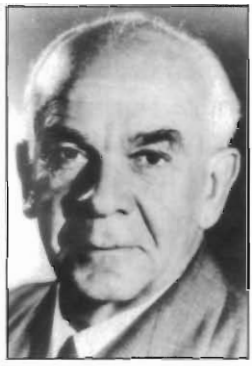
Shortly after VE Day in 1944 General Smuts recalled him from active service to become scientific adviser to the Prime Minister and to set up the CSIR. After five years he resigned to return full-time to his former post as Direc-

tor of the Bernard Price Institute, but he remained a member of the CSIR Council until 1954 when he became Deputy Director of the Atomic Energy Research Establishment at Harwell in England. Four years later he became Director and was knighted in 1960, a year before he retired.

In addition to being a Fellow of the Royal Society of London and of the Royal Society of South Africa, Sir Basil received honorary degrees from the Universities of Cape Town, Cambridge, Witwatersrand, Southampton, Natal and Rhodes. He was the first Chancellor of Rhodes University.

He received the South African Medal from the SA Association for the Advancement of Science in 1941, the Chree Medal of the Physical Society of London in 1943, the Hughes Medal of the Royal Society in 1945, the Silver Medal of the Royal Society of Arts in 1949 and the Elliot Cresson Medal of the Franklin Institute of Pennsylvania in 1950. Dr Schonland died in 1972.

Dr Petrus Johann du Toit
CSIR President
1950–1952



Du Toit was appointed as President of the CSIR after his retirement as director of the Veterinary Research Institute at Onderstepoort, very much in a caretaker capacity while Dr Naudé was being groomed to take over. He chose to remain aloof of politics, was known for his innate humility and readiness to give credit where it was due. His wit and keen sense of fun made him a much-sought-after speaker at various functions. He was one of the most brilliant scientists the country has ever produced, and was highly respected in local and international scientific circles through his excellent research work and association with Onderstepoort and as Chairman of the Scientific Council for Africa South of the Sahara.

Du Toit was born in 1888 at Somerset Strand, the son of one of the founders of the *Die Genootskap vir Regte Afrikaners* and editor of *Di Patriot*, DF du Toit and nephew of Rev SJ du Toit, early translator of the Bible into Afrikaans. He matriculated at the Hoër Jongenskool, Wellington, earning

the highest marks in the province, and took his first degree at Victoria College (later the University of Stellenbosch) where he was tutored and inspired by the famous palaeontologist, Dr Robert Broom. He was awarded the Queen Victoria Scholarship which enabled him to continue his studies in Berlin, Halle and Zürich. He obtained a PhD in zoology from the University of Zürich in 1912. On his return to South Africa he paid a visit to the Veterinary Research Institute at Onderstepoort and met its famous founder Sir Arnold Theiler who persuaded him to study veterinary science. For this purpose he returned to Europe and was awarded the DrMedVet degree in 1916 by the University of Berlin. He continued his research work in Germany during World War I.

On his return to South Africa in 1918, Theiler appointed him as senior research officer at the Veterinary Research Institute, Onderstepoort. In 1920 he became Professor of Contagious Diseases in the newly founded Faculty of Veterinary Sciences of the University of Pretoria. In 1921 he was appointed Deputy Director of Veterinary Science Education and Research, and in 1927 he succeeded Theiler as Director of Veterinary Services and became Dean of the Faculty of Veterinary Sciences. In 1945 he was appointed a member of the first council of the CSIR; and after his retirement from Onderstepoort in 1948 he became Deputy President of the CSIR and in 1950 served as President for two years. From 1952 to 1963 he continued his association with the CSIR as adviser to the president on biological and medical research.

He was the first President of the Council for Science in Africa South of the Sahara, a position he held from 1950 to 1960, and was elected a Fellow of the Royal Society, London, in 1951. He received honorary doctorates from the Universities of Stellenbosch, Cape Town, Utrecht, Witwatersrand, Glasgow, Rhodes and the Orange Free State. He received the Senior Captain Scott Medal of the SA Biological Society (1929), the SA Medal and Grant of the SA Association for the Advancement of Science (1934), the Havenga Prize for Science and Art (Medicine) of the SA Akademie vir Wetenskap en Kuns (1947) and the Bernhard Nocht Medal for Tropical Medicine, Hamburg, Germany (1938). Dr du Toit died in 1967.

Dr Stefan Meiring Naudé
CSIR President
1952–1971

Dr Naudé, a physicist, represented the classic Western-style academic researcher. He wielded the sceptre with characteristic drive and energy. Like Schonland, he too can be characterised as a benevolent dictator. He encouraged competition among scientists and gave them the freedom to do what they wanted in the belief that they would then give their best. This approach was highly appreciated by his directors who felt empowered and trusted.

The image and management of the CSIR was modelled according to its Western counterparts and the research philosophy was in line with what Vannevar Bush described in his report, *Science – The Endless Frontier*. However, Naudé did not lose sight of the CSIR's obligation to industry. He cautioned the discipline-oriented institutes to maintain a healthy balance between basic and applied research and advised them to keep in close touch with industry to find out what they needed.

Naudé was very reserved and professional, but not aloof, always involving even junior staff in feedback sessions and inviting staff to his home. He was Mr Science in South Africa, holding the positions of President and Chief Executive Officer of the CSIR, head of the foundation responsible for research funding and Chairman of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns, at the same time among numerous other offices. The healthy growth of these institutions of necessity put an end to this centralisation of power in one person, which at the time lent a degree of coherence to the scientific community.

Naudé was born at De Doorns, Cape Province, in 1904. He received an MSc in physics from the University of Stellenbosch and continued his studies at the University of Berlin under scientists such as Nobel Prize winners Einstein, Von Laue, Planck and Nernst. After receiving his doctorate in 1928 he carried out research for a year, working with Professor Paschen, at the Physikalisch-Technische Reichsanstalt in Berlin Charlottenburg and then joined the Ryerson Physical Laboratory in Chicago, USA, where

he continued his research under Professors Mulliken and Compton, establishing his scientific reputation in the field of atomic spectra.

He returned to South Africa to become Senior Lecturer in Physics at the University of Cape Town and in 1934 Professor in Experimental Physics at the University of Stellenbosch.

When the CSIR was founded in 1945 he was appointed the first Director of the National Physical Laboratory. In 1950 he became Vice-President and two years later President of the CSIR. After his retirement in 1971, he served as scientific adviser to the Prime Minister for five years.

During his career he was the first Chairman of the South African Institute of Physics, Chairman of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns, President of the Association for the Advancement of Science and President of the Associated Scientific and Technical Societies of South Africa. He was Chairman of the Council of the University of Pretoria from 1972 to 1982 and Chairman of the Simon van der Stel Foundation.

Among the awards he received were the Havenga Prize for Scientific Research from the SA Akademie vir Wetenskap en Kuns, the De Beers Gold Medal for Physical Research from the SA Institute of Physics and the SA Medal of the Association for the Advancement of Science.

He was also awarded honorary doctorates by the following universities: Potchefstroom, Witwatersrand, Cape Town, Stellenbosch, Orange Free State, Natal, Pretoria and Unisa. In 1982 he received the country's highest civil honour, the Decoration for Meritorious Service. He died in 1985.

Dr Christiaan van der Merwe Brink
CSIR President
1971–1980

Dr Brink, an organic chemist, was a very affable extrovert and strong leader. He left no doubt about who was in charge. He had a phenomenal memory for names and faces. Associates complained that it would take them up to half an hour to move through the reception area of the airport, be-

cause he seemed to know everyone and remembered the minutest details about their families. This endeared him to everyone he came into contact with. Although Brink followed the dictatorial management style of his predecessors, it was softened by this genuine people orientation.

He got on well with everybody including the politicians he had to deal with. Many an appointment ran over its scheduled time because he enjoyed the company of people so much. Despite this, he never left his office without finishing the chores of the day. After one such a visit by the British ambassador and Sir Euain Maddock, chatting away amiably, he slapped the slightly built Sir Euain on the shoulder as a parting gesture and nearly knocked him off his feet. On the way to the lift, Sir Euain remarked to the ambassador: 'A hearty fellow, isn't he!' – a perfect description of the sociable Brink.

Brink's pragmatism set the scene for the radical change that was set in motion six years after his death. He revisited the CSIR's brief and made a visible attempt to bring the CSIR, the universities and industry together in an effort to co-ordinate technological research and to increase the emphasis on applied research.

Brink was born in the district of Piketberg in 1915 and studied at the University of Stellenbosch, obtaining an MSc in chemistry in 1936. From 1937 to 1943 he worked as a research scientist at the SA Iron and Steel Industrial Corporation (Iscor).

In 1944 he returned to academic life, becoming a senior lecturer at the University of Pretoria where he obtained his DSc in 1954. In 1959 he was appointed Professor of Organic Chemistry at the University of the Orange Free State.

Dr Brink joined the CSIR in 1968 as a Vice-President and became Deputy President before his appointment as President in 1971. He died in 1980.

Dr Brink was Chairman of the SA Akademie vir Wetenskap en Kuns. He was awarded the AECI Gold Medal by the SA Chemical Institute for research work published in 1966, and in 1976 was awarded the Institute's Gold Medal for his contributions to the advancement of chemistry in South Africa. Honorary doctorates were conferred on him by the universities of the Witwatersrand, Stellenbosch, Pretoria and Cape Town. In 1980 he received the Decoration for Meritorious Service from the State President.

THE CAPTAINS OF TECHNOLOGY

The transformation of the CSIR from an entrenched research and development organisation to an essentially market-oriented contract research organisation was by all standards a radical step. Its successful conclusion has generally been attributed to the 'right people at the right time'. What shaped the lives of its two chief architects, Garbers and Clark, that motivated and enabled them to take the course they did?

Christoph Friedrich Garbers
CSIR President
1980–1990

Chris Garbers claims modest roots. As a small boy, his father was placed in a concentration camp during the Anglo-Boer War. The family farm near the Swaziland border, to which they returned after the war, had been all but destroyed. The nearest school was some 70 km away. To obtain an education, he boarded on a farm nearby for which privilege he had to perform a number of chores. This meant he had to run the 5 km to school and back every day. The image of the hard-working, barefoot little boy running to school has remained with Garbers and contributed a great deal to his empathising with the less privileged. His father eventually did an apprenticeship and started his own business.

Dr Meiring Naudé, who had a farm in the vicinity, often did business with him. It was only logical that Mr Garbers should consult the much-revered Dr Naudé about the future education of his two sons. Naudé had no hesitation in advising him to let them study science and then 'everything would be all right'. The two boys duly followed this advice and did more than 'all right'. They excelled in their studies and both were appointed university professors, the one going on to become President of the CSIR and the other of the Human Sciences Research Council – Naudé had not erred.

Garbers attributes his success to a very happy family life, the close comradeship he and his brother shared, and to the values he grew up with – in particular, a keen sense of responsibility and being ever alert to his en-

vironment. His mother always reminded them to be on the look-out for things that needed attention like a broken gate or fence. He had a strong feeling of wanting to be a source of pleasure to his parents.

One of the driving forces in his life has been the persistent sense of not doing things well enough, which is the hallmark of the perfectionist. His analytical acumen comes from an all-pervasive interest in mathematics. He would neglect his other school work, but never tired of doing maths. However, he chose to specialise in chemistry as he felt it had more scope, his perception being that a career as a mathematician would be restricted to teaching the subject.

He could have gone a number of different directions – remaining at the Swiss university was an option as were the numerous opportunities to get on the molecular biology bandwagon in the aftermath of the discovery of the double helix. However, destiny took its course.

His marriage to Barbara has been a very happy one, much of which he attributes to her understanding of his intense preoccupation with books.

Garbers is a scholar and a philosopher who thoroughly researches and analyses whatever comes to hand. This attribute enables him to see things from a global perspective. A perfectionist, he never ceases to strive for improvement, a relentless quest for optimising. He is a team player who pays attention to the opinions of others, and reflected the prevailing mood of consensus politics.

During the events that led to the restructuring of the CSIR Garbers asked the right questions. His sensitivity and ability to respond and adapt to the environment, and his integrity to stick to the path dictated by his inner conviction, enabled him to translate his conviction into reality. He is the first to admit that although he played his part in the moves that led to the big change, he was not the right person to drive the actual implementation. He is recognised for the courage he had to overthrow the existing order of an organisation the size and importance of the CSIR.

Christoph Friedrich Garbers was born in Piet Retief on 21 August 1929, where he also completed his schooling. He was awarded a BSc and an MSc degree in chemistry from the University of Pretoria, both with distinction. After nine months as a research officer at Klipfontein Organic Products Corporation, he left to continue his studies at the University of Zürich, in Switzerland under Nobel Laureate Paul Karrer. He held an appointment at the university from 1952 to 1954, obtaining a DPhil, once again with distinction, at the end of this period. He returned to South Africa to work at the CSIR. After four years, he accepted a post at the University of Stellenbosch, where he progressed to Professor of Organic Chemistry and Director of the CSIR Unit for Polyene Chemistry.

He was appointed as Vice-President at the CSIR in 1978 and was promoted to Deputy President in 1980. In the same year, following the sudden death of Dr Chris van der Merwe Brink, he became the fifth President of the CSIR. He retired on 1 October 1990 after which he served as Chairman of the Foundation for Research Development (1990-2), the Scientific Advisory Council (1991-4), and the Certification Council for Technikon Education (1989-95).

During his active career he served on the boards, councils and commissions of many institutions and companies. He is at present Chancellor of the University of South Africa, Vice-President of the Hans Merensky Foundation, member of the Altech board of directors, Honorary President of EXPO for Young Scientists, and member of the IUPAC-UNESCO International Chemistry Council. He is a member of the President's National Commission on Higher Education. He recently served on the Working Group with the ANC, Cosatu and Sanco on the Science and Technology Initiative, the Advisory Committee on the Tertiary Sector Crises of the Minister of Education and the Advisory Group to the Minister of Arts, Culture, Science and Technology.

He is the author of 67 scientific publications and has contributed to three books. In 1977 he was awarded the Havenga Prize for Chemistry by Die Suid-Afrikaanse Akademie vir Wetenskap en Kuns, followed in 1980 by the Gold Medal of the South African Chemical Institute. In 1989 he received the State President's Order for Meritorious Service (Class I) Gold, and in 1990 also the gold MT Steyn Medal of Die Suid-Afrikaanse Akademie and the gold South Africa Medal of the South African Association for the Advancement of Science. In addition he has been awarded honorary doctor's degrees in science by the Universities of South Africa (1989), Cape Town (1990), Stellenbosch (1991) and Pretoria (1994). In 1991 he received the Percy Fox Foundation Annual Award and the Hendrik van Eck Medal of the South African Chemical Institute.

At the invitation of the publishers, biographical information on Dr Garbers has been included in *Men of Achievement*; *International Who's Who*; *International Who's Who of Contemporary Achievement*; *International Directory of Distinguished Leadership*; *5000 Personalities of the World*; *Who's Who in Science*; *International Leaders in Achievement*; *Who's Who in the World*; and *Africa Who's Who*.

James Brian Clark
CSIR President
1990–1995

Brian Clark started working at the CSIR at age 16, the day after he wrote his last matric paper. This commitment was already an indication of the young man's drive to achieve his goal in life, which at that stage was to get an education in science.

His subsequent perseverance in obtaining his degrees part-time is another facet of his tenacious character. To start a career as a lab assistant in a prestigious organisation, where professional competition was at best severe, and rise through the ranks to the very top position at the age of 41 is indeed an achievement. What contributed to the shaping of so remarkable a performance?

As a small boy, Clark was encouraged by his father not to deliberate about things but to go out and do it. This attitude encouraged experimenting and a sense of being able to do anything he wanted to, at least to try anything, including an 'experiment' that ended up burning down the nursery of the family's flower business. His father died while he was still at school, and overnight the future had become considerably more complicated and uncertain. He now needed to study part-time after matriculation to obtain a tertiary education.

When Clark went for his job interview with the CSIR he was understandably nervous and anxious to succeed as on this depended his opportunity to go to university. The interview digressed into what qualities were required to make a great researcher. Elaborating on the topic, Dr Carl Pistorius, Clark's future boss, recalled his association with one of the great names in research in the United States, who happened to be a collector of ancient art. Therefore one of the criteria was to be a collector.

Question: Do you collect anything? Too embarrassed to say what he collected (namely company lapel badges), but firmly under the impression that since he was a collector he was obviously going to be a great researcher, he responded that yes, he was a collector but he had forgotten just then what he collected! How could he compete with a great scientist who

ransacked Mexican graves for his collection!

For the first 10 years of his career, Clark had the privilege to be in a team that was working at the cutting edge of science. His perception of the prevailing culture in his immediate environment was that there had to be a right answer to every question and if you didn't get it, you were a failure. The atmosphere, although casual on the social level, seemed so competitive at the professional level it bordered on the destructive. By the time he left for his postdoctoral experience overseas, he had already made up his mind that he was going to do something different on his return.

The overseas experience exposed him to a variety of research cultures. In the German institution the quest for new understanding was characterised by a process of observing, analysing, interpreting and, above all, learning that there was nothing wrong with not finding answers to everything. The research leaders he worked with in the United States again impressed him with their strong emphasis on the relevance of research work.

Armed with these new insights, Clark came back to South Africa intent on embarking on a new career as soon as his contractual obligations had been met. Above all, he wanted to make a contribution to industry. He already had an offer from De Beers Diamond Research Laboratories which would involve doing industrial research. However, he faced an entirely different situation on his return to his former high-pressure physics laboratory. The CSIR was about to close down this section after the sudden death of Dr Carl Pistorius. Because of his high standing in the scientific world, management was convinced that without him the activity had no viability.

The position at De Beers, although attractive, had the disadvantage of restricting Clark to work in a very narrow area of research. He immediately saw the opportunity of combining the best of both worlds by negotiating with De Beers to do the work under contract at the CSIR. This would give him the scope to make the contribution but he could also remain active in a much wider field of research. They agreed, and overnight the survival of the High Pressure Physics Section was secured.

They were now doing exactly what Clark had envisaged, working directly with industry, doing product development and working at the highest level. This group had the benefit of actually following the implementation of fundamental research through to the production line, resulting in profitable sales. Soon after this Dr Johan Coetzer's revolutionary high energy density battery project came off the ground in another section of the institution, later to be transferred to Anglo American under the name of the Zebra battery. They were fortunate to have a forward-looking director in Dr Albertus Strasheim who had for some time been urging researchers to get closer to industry.

A highly productive personal period followed for Clark and his associates in the Materials Development group, gaining research experience and interacting with industry. Further contracts were entered into and the experience of working on a carefully defined project with a client reinforced the new approach. Future possibilities seemed endless. This was the beginning of the vision Clark had for the way the CSIR should operate and sowed the seeds for the shape of things to come 10 years later.

These examples of successful contract research took place during the Brink era. Observing developments in the field of materials science, Brink approached Clark to head a Co-operative Scientific Programme on materials. Clark declined, because he loved what he was doing. Brink wisely did not press him, but requested instead to be introduced to the top materials people on the international scene. A meeting was arranged for a South African delegation, including Brink, Dr Louw Alberts and Clark to meet with some materials experts in Washington.

Following this, Brink was convinced of the importance of setting up the proposed Materials Programme and again offered Clark the job, with the concession that he could retain his position as head of High Pressure Physics at the same time.

Clark was now in touch with the whole range of South Africa's materials research efforts and needs, and saw the potential of a focused initiative in this area for the country. By 1983 the groundwork had been laid for the establishment of a separate institute dedicated to materials research. An international conference hosted by the CSIR put the seal on the initiative, and the National Institute for Materials Research came into being soon afterwards with Clark as its first Chief Director.

Clark's experience had convinced him of two things. Firstly, that market-driven research was the right way to go and, secondly, that the CSIR was totally out of touch with its environment. By 1985, he was thoroughly frustrated with the inflexible bureaucracy the CSIR had fallen into, as well as with the political morass the country was in. He started seriously considering leaving South Africa and was in the process of following up a job offer in Australia. Right at that time the position of Executive Vice-President with the specific responsibility of technology transfer was advertised and he decided to apply.

His saw it as an opportunity to make a meaningful contribution. Should his application be successful, he intended to tackle the job in an all-out attempt to implement a new approach to research at the CSIR. He was still firmly convinced that the presidency itself was unattainable as he was critical of the government's policies. He felt he had nothing to lose and could risk everything to achieve his vision. The reaction to his candidacy seemed

to him lukewarm and he had already drafted his acceptance to the Australian offer, when he received word of his appointment.

A second, far more radical proposal about the future course of the CSIR had been submitted to the Board, the first one having proved unacceptable as it was simply a conservative adjustment to adapt to a reduced income. The Board had no hesitation in deciding that Clark was the man to make the new initiative work.

Shortly after Clark became President in 1990 Derek Keys and Paul Kruger were appointed to the CSIR Board. Clark's association with these two leaders from industry added a new dimension to his thinking. Keys's concept of the role of a top manager had a profound effect on Clark's approach to his new responsibility. Keys emphasised the importance of the chief executive's function to look ahead and anticipate future events that could influence the organisation, to step back and reflect on the system from outside in a completely different manner and to ensure that he managed his life in such a way as to create time to fulfil this function. Clark recognised the potential in his and his colleagues' jobs to become completely event-driven and took heed of Keys's words. Kruger's insight into and experience of how industry worked proved invaluable. Clark came to realise that the Executive had to focus on fewer issues in order to do them well. These insights laid the foundation for the watershed strategy of 1993.

In the ensuing period Clark set about positioning the CSIR for its future role at both national and international levels, an initiative which entailed much travelling to make the appropriate high-level contact. These efforts were often misunderstood among staff who criticised him for becoming less visible within the organisation as he delegated much responsibility to his executive team.

The release of Mandela had put the seal on the dominant role the ANC would be playing in South Africa's political future. Contact with in particular Dr Frene Ginwala and Jayendra Naidoo was critical in Clark's understanding of how to position the CSIR for the future – Ginwala, who led the ANC's discussions with the CSIR during and after the IDRC-sponsored study on a science and technology policy for South Africa, and Jayendra Naidoo, who became Co-Chairman with Clark of the subsequent STI. Clark's efforts ensured that the CSIR remained one jump ahead and with the hard-won flexibility that is now part of the organisation's culture, it is confident to meet whatever challenge the future holds.

Clark, a physicist like Naudé, is the energetic change agent, the adroit go-getter with the courage to pursue his vision in the face of much opposition. He introduced strategic thinking into the organisation and a totally new approach to management in general and technology management

in particular. He too reflected a new era, that of democracy. His leadership style is forceful and directive. He has no hesitation in taking decisive action, but will seek and listen to the opinions of others. He had developed the discipline to desist from intervening to allow others to grow. The newly created climate, to which he contributed extensively, encourages co-operation with associates. In its new guise, the Board can apply the brakes, should they ever be required.

James Brian Clark was born in Pretoria on 27 January 1949. He attended Waterkloof Preparatory School (Pretoria), Kingswood College (Grahamstown) and Christian Brothers College (Pretoria). After writing his matric exams in 1965, he started working at the National Physical Research Laboratory (NPRL) as a lab assistant with the view to studying part-time. He obtained a BSc (1970), an MSc degree in physics in 1971 and a DSc in physics in 1973 from the University of Pretoria. Dr Clark became head of the High Pressure Physics Division of the NPRL in 1976 and from 1979 also held the job of manager of the National Programme for Materials Science, under the CSIR's Co-operative Scientific Programmes, for two years. In 1981 he was appointed Assistant Director of the NPRL. He was instrumental in the founding of the National Institute for Materials Research in 1983 of which he became the first director. In 1986 he was appointed Vice-President of the CSIR with the specific responsibility for managing technology transfer, and in 1990 he became the sixth President of the CSIR. He resigned in 1995 to become the Managing Director and Chief Executive Officer of Telkom.

Dr Clark did postdoctoral research at the University of Munich in 1974 as the holder of an Alexander von Humboldt Fellowship, and in 1975 was awarded a postgraduate research grant by the Material Research Laboratory of the Pennsylvania State University. He has received numerous awards, among them: the Silver Jubilee Medal from the SA Institute of Physics (1981); the British Association Medal from the SA Association for the Advancement of Science (1983); the Meiring Naudé Medal from the Royal Society of South Africa (1984); the FOYSA award from the Junior Chamber of Commerce and Shell SA (1985); an honorary professorship of the University of the Witwatersrand (1985); the J&B Achievers Award for Technology (1988); the Alexander von Humboldt Foundation medal for promoting international co-operation (1992); the Claude Harris Leon and Percy Fox Foundation Award for Science and Technology (1993). He was made a Fellow of the Royal Society of Southern Africa in 1988 and was elected a Foreign Member of the Royal Swedish Academy of Engineering Sciences in 1994.

Geoffrey Graham Garrett
CSIR President
1995–

Geoff Garrett grew up in a small town in England in a very sporting community. His mother was a swimmer and father a local soccer player of note. His passion for winning (and dislike of losing!) developed through his early sporting and schooling career.

Intending to specialise in chemistry, he discovered the fascination of metals and materials at Cambridge, where also, after some initial setbacks (including a first-round knockout in his first varsity match), he achieved a boxing blue. He still maintains, however, that his major achievement at Cambridge was meeting and persuading Janet, a native Capetonian, to marry him. Never one to be beaten, he had to follow her back to South Africa to make this happen.

South Africa and academic life at the University of Cape Town gave him enormous opportunities to experiment ('an enthusiast's dream!'). Becoming warden of a new 400-man residence at age 26 also gave him great scope to build on his then 'seat-of-the-pants' management experience. This student interaction, together with his later involvement with Life Line counselling and subsequent marriage counselling, honed his listening skills and developed his already strong people orientation. He is a strong supporter of the maxim 'all business is people business'.

Wits University, and being at the centre of South Africa's industrial heartland, progressively saw his inclinations move from the purely academic toward goal-oriented research and development and entrenched the realisation of the importance of implementing research findings to the benefit of industry and society at large. Another strong influence has been that of his close colleague and distinguished professor of minerals processing, Peter King, who always provided an uncompromising role model around excellence – an enduring passion for both of them to this day.

Having worked closely with Brian Clark in the early 1980s, as an adviser to the new National Institute for Materials Research and in building the materials community in South Africa, he joined the CSIR in 1986 to help

create a new vision for the organisation. As a friend and mentor, Clark gave him the space and encouragement to grow as a manager and leader.

Garrett is at once very people oriented and highly competitive and goal directed. An energetic action man of 'seize-the-day' persuasion, his inherent tendency to be impulsive on occasion is generally well balanced by a firm commitment to participation and the enormous value addition of high quality team-work in both direction setting and delivery. His broad approach might be characterised by what he calls his 6P Guide: Never compromise on **p**lanning and **p**reparation, always retain focus (**p**hocus), be **p**assionate about everything you do, believe in and build **p**eople and be **p**ersistent, delivering on time, every time. Highly approachable, he gives credit where credit is due and can disarm a frantic employee under pressure to deliver to his high standards with a warm smile and a friendly pat on the shoulder.

An excellent speaker, he has a talent for being able to hold an audience in the palm of his hand. He can tell a funny story with a sense of timing that many a professional performer might envy. This ability has turned serious feedback sessions to organisation leadership into enjoyable learning occasions.

Geoff Garrett was born in the United Kingdom on 9 March 1948. He obtained his first degree in 1969 from Cambridge University, majoring in physical metallurgy, followed by a PhD at the same university for work in the area of fracture mechanics and fatigue in aluminium alloys.

He emigrated to South Africa in 1973 to join the newly-formed Department of Metallurgy at the University of Cape Town. Here he also became warden of a university residence, played first team soccer for UCT, was president of the university's Boxing Club and a lecturers' representative on the University Senate.

In 1979, at the age of 30, he was appointed to the Chair of Physical and Fabrication Metallurgy at the University of the Witwatersrand, initially as Associate Professor and 18 months later as full Professor and subsequently Head of the Department. He was recruited to build the physical metallurgy 'leg' of a then predominantly extractive metallurgy/minerals processing department, which grew over the following seven years from a very small base into a large undergraduate class with an internationally accredited curriculum, and with a significant and multidisciplinary postgraduate school, largely industrially funded. He was elected chairman of the South African Region of the international Institution of Metallurgists, of which he is a Fellow. He is a Fellow of the SA Institute of Mining and Metallurgy and a registered professional engineer. He remains an Honorary Professor of the University of the Witwatersrand.

During his academic career he published 78 papers in international journals and conference proceedings, wrote more than 100 research reports for industry, authored a number of patents, was the editor of three books on the subject of fracture, was an Editorial Board member of four international journals, carried out research at universities in Canada and the USA, and was a visiting fellow/professor at prestigious academic institutions in both the USA and the UK.

Garrett joined the CSIR in 1986 to become Chief Director of the then National Institute of Materials Research. He played a leading role in the restructuring of the CSIR during the mid-1980s and became Director of the newly constituted Division of Materials Science and Technology, now one of the CSIR's largest operating divisions. In January 1990 he was promoted to Deputy Group Executive: Research, Development and Implementation and appointed Executive Vice President: Operations in October 1990. In 1991 he attended Stanford University Business School's Executive Programme for formal management training.

In addition to the workload of his vice presidency, he led the merger of the Chamber of Mines Research Organisation with the CSIR to form the new Division of Mining Technology, which he guided through its first year as acting director. This experience stood him in good stead when the next merger had to be negotiated, that of the Fishing Industries Research Institute with the Division of Food Technology of the CSIR. He also initiated the driving of the CSIR's Total Quality Management initiative and established the Advanced Leadership Programme aimed at developing talented leaders in the organisation.

After Clark's resignation in March 1995, Garrett was appointed Acting President as from June, the first three months having been handled on a rotation basis. The appointment of a new president was delayed by the process of appointing a new, representative Board. Once this had been accomplished the Board had no hesitation in appointing Garrett as the seventh president of the CSIR in November 1995.

Councils and Boards

MEMBERS OF THE CSIR'S FIRST COUNCIL 1945

Dr BFJ Schonland	*President, Chairman and Chief Executive Officer*
Dr FJ de Villiers	*Industrial Adviser, Department of Commerce and Industry*
Dr PJ du Toit	*Director, Division of Veterinary Service, Department of Agriculture*
Dr SH Haughton	*Director, Geological Survey*
Dr Bernard Price	*Chairman, Victoria Falls and Transvaal Power Company*
Dr J Smeath Thomas	*Master, Rhodes University College*
Mr TP Stratten	*Consulting Engineer, Union Corporation*
Dr HJ van Eck	*Chairman, Industrial Development Corporation*
Dr RW Wilcocks	*Rector, University of Stellenbosch*
Mr JE Worsdale	*Chairman, Cape Portland Cement*

CSIR COUNCIL 1984–1987

COUNCIL 1984

Dr CF Garbers	*President/Chairman*
Dr CF Boyce	(retired at end of 1984)

Mr DP de Villiers (retired at end of 1984)
Mr MT de Waal
Prof DS Henderson
Dr LB Knoll
DR JGH Loubser (retired at end of 1984)
Mr E Pavitt
Mr RA Plumbridge
Prof OW Prozesky
Dr C van der Pol
Prof HP van der Scijff
Dr WP Venter

COUNCIL 1985

Dr CF Garbers *President/Chairman*
Mr MT de Waal
Prof DS Henderson
Dr LB Knoll
Mr E Pavitt (retired at end of 1985)
Mr RA Plumbridge
Prof WO Prozesky
Mr JA Stegmann (appointed 1985)
Mr E van As (appointed 1985)
Dr C van der Pol
Prof HP van der Schijff
Dr WP Venter

COUNCIL 1986

Dr CF Garbers *President/Chairman*
Mr MT de Waal
Dr HB Dyer (appointed 1986)
Prof DS Henderson
Dr LB Knoll
Mr RA Plumbridge
Prof OW Prozesky
Mr JA Stegmann
Mr E van As
Dr C van der Pol
Prof HP van der Schijff (retired during 1986)
Dr WP Venter

COUNCIL 1987

Dr CF Garbers	*President/Chairman*
Mr MT de Waal	(retired during 1987)
Dr HB Dyer	
Prof DS Henderson	(retired at end of 1987)
Dr LB Knoll	
Mr RA Plumbridge	
Prof OW Prozesky	(retired at end of 1987)
Mr JA Stegmann	
Mr E van As	
Dr C van der Pol	
Mr PJ van Rooy	(appointed 1987)
Dr WP Venter	

CSIR BOARD 1988–1995

In April 1988 after the new Scientific Research Council Act was passed the CSIR Council was reconstituted and became known as the CSIR Board.

Dr L Alberts	*Chairman* from June 1988
Dr CF Garbers	*President/ Chairman* up to April 1988
Dr HB Dyer	
Dr LB Knoll	
Mr RA Plumbridge	
Mr JA Stegmann	
Mr E van As	
Dr C van der Pol	
Mr PJ van Rooy	
Dr WP Venter	
Prof DR Woods	(appointed 1988)

CSIR BOARD 1989

Dr L Alberts	*Chairman*
Dr CF Garbers	*President*
Dr HB Dyer	
Dr LB Knoll	
Mr RA Plumbridge	
Mr JA Stegmann	
Mr E van As	
Dr C van der Pol	

Mr PJ van Rooy
Dr WP Venter
Prof DR Woods

CSIR Board 1990

Dr L Alberts	*Chairman*
Dr CF Garbers	*President* (retired 1990)
Dr JB Clark	*President* (appointed 1990)
Dr HBDyer	
Dr LB Knoll	
Mr RA Plumbridge	
Mr JA Stegmann	(retired during 1990)
Mr E van As	
Dr C van der Pol	(retired during 1990)
Mr PJ van Rooy	
Dr WP Venter	
Prof DR Woods	

CSIR Board 1991

Dr L Alberts	*Chairman* (retired 30 June 1991)
Mr P duP Kruger	*Chairman* (joined 28 January and became Chairman 30 June 1991)
Dr JB Clark	*President*
Dr HB Dyer	
Mr JC Hall	(appointed July 1991)
Mr DL Keys	(appointed mid-1991, resigned end of 1991 on his appointment to the Cabinet)
Dr LB Knoll	
Mr RA Plumbridge	
Dr GS Sibiya	(appointed 1991)
Mr E van As	
Mr PJ van Rooy	(retired at end 1991)
Dr WP Venter	
Prof DR Woods	(retired mid-1991)

CSIR Board 1992

Mr P duP Kruger	*Chairman*
Dr JB Clark	*President*
Mr L Boyd	
Dr HB Dyer	

Mr JC Hall
Dr LB Knoll
Mr RA Plumbridge
Dr GS Sibiya
Mr E van As
Mr WC van der Merwe
Dr WP Venter

CSIR BOARD 1993

Mr P duP Kruger	*Chairman*
Dr JB Clark	*President*
Mr L Boyd	
Dr HB Dyer	(deceased 5 March 1993)
Mr JC Hall	
Dr LB Knoll	
Dr IF Matsepe-Casaburri	(appointed mid-1993)
Mr RA Plumbridge	
Dr GS Sibiya	
Mr E van As	
Mr WC van der Merwe	
Dr WP Venter	

CSIR BOARD 1994

Mr P duP Kruger	*Chairman*
Dr JB Clark	*President*
Mr L Boyd	
Mr JC Hall	
Dr LB Knoll	(retired end 1994)
Dr IF Matsepe-Casaburri	
Mr RA Plumbridge	
Dr GS Sibiya	(resigned March 1994)
Mr E van As	
Mr WC van der Merwe	
Dr WP Venter	

CSIR BOARD 1995 UP TO AUGUST 1995

Members' term of office was extended until the end of August 1995 while a more representative Board was being selected.

Mr P duP Kruger	*Chairman*
Dr JB Clark	*President* (resigned end March 1995)

Mr L Boyd
Mr JC Hall
Dr IF Matsepe-Casaburri
Mr RA Plumbridge
Mr E van As
Mr WC van der Merwe
Dr WP Venter

CSIR BOARD FROM OCTOBER 1995

Dr WP Venter	*Chairman*
Dr GG Garrett	*President* (appointed November 1995)

Mr L Boyd
Prof AA Eberhard
Dr D Gihwala
Dr IF Matsepe-Casaburri
Mr KC Phihlela
Prof JPF Sellschop
Ms LF Shope-Mafole
Prof EM Tyobeka
Mr E van As

CSIR Awards 1983–1995

MERIT AWARDS

1983	Dr J Coetzer	*National Institute for Materials Research*
	Dr F Hengstberger	*National Physical Research Laboratory*
	Dr VP Joynt	*Applied Chemistry Unit*
1984	Mr WJ Botha	*National Institute for Telecommunications Research*
	Dr JT Fourie	*National Institute for Materials Research*
	Mr PP Roets	*National Research Institute for Mathematical Sciences*
1985	Mr JHJ Filter	*National Electrical Engineering Research Institute*
	Dr A Pizzi	*National Timber Research Institute*
	Dr JC Vogel	*National Physical Research Laboratory*
1986	Dr DE Baker	*National Institute for Aeronautics and Systems Technology*
	Dr AH Botha	*National Accelerator Centre*
	Dr PJ van der Walt	*National Food Research Institute*
1987	Adv TJ Botha	*Roads and Transport Technology*

	Mr J Sigalas	*Materials Science and Technology*
	Dr PS Steyn	*Food Science and Technology*
1988	Mr F Anderson	*Aeronautical Systems Technology*
	Dr NR Comins	*Materials Science and Technology*
	Dr TG Watson	*Food Science and Technology*

OUTSTANDING ACHIEVERS AWARDS

1989	Mr HN Jungwirth	*National Accelerator Centre, FRD*
	Mr J MacGibbon	*Materials Science and Technology*
	Dr RE Oberholster	*Building Technology*
	Mr JN Olivier	*Microelectronics and Communications Technology*
	Dr DH Swart	*Earth, Marine and Atmospheric Science and Technology*
	Mr AJ van Wyk	*Aeronautical Systems Technology*
1990	Mr FC Rust	*Roads and Transport Technology*
	Dr MM Thackeray	*Materials Science and Technology*
	Dr BM van Vliet	*Water Technology*
	Dr AJ Vermeulen	*Aeronautical Systems Technology*
	Dr Dwight Walter	*Materials Science and Technology*
	Mrs S Wittstock	*Microelectronics and Communications Technology*
1991	Dr PJ Ashton	*Water Technology*
	Dr C Boothroyd	*Materials Science and Technology*
	Mr MJC Marsh	*Microelectronics and Communications Technology*
	Mrs B Mogane-Ramahotswa	*Water Technology*
	Mr J Olivier	*Materials Science and Technology*
	Mr A van der Bergh	*Corporate Human Resources and Services*
1992	Dr H Booyens	*Microelectronics and Communications Technology*
	Dr J Cizek	*Textile Technology*
	Dr J Dekker	*Energy Technology*
	Dr DCSD Grobler	*Corporate Environmental Services*
	Mr R Speth	*Aeronautical Systems Technology*
	Dr GJ Wright	*Materials Science and Technology*

1993	Dr WJ Botha	*Microelectronics and Communications Technology*
	Dr NR Comins	*Materials Science and Technology*
	Mr JH le Roux	*Textile Technology*
	Ms CA O'Brien	*CSIR Conference Centre*
	Mr LR Sampson	*Roads and Transport Technology*
	Mr GP Smith	*Forest Science and Technology*
1994	Dr JH de Beer	*Earth, Marine and Atmospheric Science and Technology*
	Dr RG Gürtunca	*Mining Technology*
	Dr S Hart	*Materials Science and Technology*
	Dr L Hunter	*Textile Technology*
	Mrs P Truter	*Materials Science and Technology*
	Mr PJ van der Westhuizen	*Microelectronics and Communications Technology*
1995	Mr H Diale	*Mining Technology*
	Ms BV Lue	*Corporate*
	Mr AJ Nepgen	*Materials Science and Technology*
	Mr FC Rust	*Roads and Transport Technology*
	Mr J Strydom	*Manufacturing and Aeronautical Systems Technology*
	MR JN Viljoen	*Microelectronics and Communications Technology*

TEAM AWARDS 1995

Fluidised Bed Design Team. Materials Science and Technology

Dr C Eleftheriades
Mr B North
Mr A Engelbrecht

Water Supply and Sanitation Team, Water Technology

Mr IA Pearson
Mr H Mokoka
Mr AW Kariuki
Mr I Manala
Mr S Hlatshweyo
Mr DD Rimmer
Ms M van Suntemartensdyk
Mr J Modiba
Mr J Xaba
Ms GS Gumbi

Integrative Environmental Impact Assessment Team

Forestek	Alex Weaver
	Pat Manders
	Brian van Wilgen
	Fred Kruger
	Max Clark
	Bernie Olbrich
Ematek	Pat Morant
	Sean O'Bierne
	Bruce Eglington
	Keith Wisemen
	Mike Burns
Watertek	Steve Ballot
	James Gordon-Lennox
Environmental Services	
	Dirk Grobler
Miningtek	Brian Protheroe
Textek	Rob Gardner
Transportek	Dave Jones

Chronology of Key Events 1945–1995[1]

1945 Dr Basil Schonland (later Sir Basil) appointed Scientific Adviser to the Prime Minister, Jan Smuts.
Research Council Bill passed by Parliament.
Scientific Research Council Act promulgated.
First formal meeting of CSIR Council.
Dr Schonland appointed President.

1946 Establishment of the CSIR's National Physical Laboratory, National Building Research Institute, Telecommunications Research Laboratory, National Bureau of Personnel Research, Library and Information Division, Scientific Liaison Offices (London and Wasington), Leather Industries Research Institute, Fishing Industries Research Institute, SA Paint Research Institute.

1947 National Chemical Research Laboratory established.
Central Workshops formed.

1948 National Bureau for Personnel Research becomes National Institute for Personnel Research.

1949 Sugar Milling Research Institute established.

1950 Dr Schonland resigns as President, and is succeeded by Dr Petrus du Toit, retired Director of the Veterinary Research Institute at Onderstepoort.
SA Wool Textile Research Institute and Bituminous Binder Research Unit established.

1952 Dr Petrus du Toit retires. Dr Stefan Meiring Naudé appointed President.

1954 National Nutrition Research Institute established.
Mr Trevor Wadley develops his novel concept of distance measurement, the tellurometer, which revolutionised surveying worldwide.

1955 Telecommunications Research Laboratory becomes NITR.
National Institute for Road Research and National Mechanical Engineering Research Institute established.

1956 NPL's Cyclotron formally commissioned.
Amalgamation of SABS and CSIR.

1957 NPL becomes National Physical Research Laboratory.
Dr Abraham (Ampie) Roux appointed Vice President responsible for drafting atomic energy research programme.
Scientific Liaison Office, West Germany, established (first in Cologne, later Bonn).

1958 National Institute for Water Research established.
Liaison Division and Library and Information Division combined to form Information and Special Services Department.
Technical Services Department, Estates Division and Administrative Services Department established.

1960 Formation of Timber Research Unit and Air Pollution Research Group.

1961 National Research Institute for Mathematical Sciences, Radio Space Research Station and Microbiology Research Group established.

1962 Scientia site dedicated to the advancement of science.
SABS and CSIR become separate organisations again.

Formation of Corrosion Group and Sorghum Beer Research Unit.
SA Inventions Development Corporation established.

1963 National Institute for Rocket Research established.

1964 Republic Observatory and the South African Wool and Textile Research Institute become part of CSIR.
Government Mechanical Laboratory incorporated into CSIR to form Mining Equipment Research Unit under National Mechanical Engineering Research Institute.

1965 National Institute for Defence Research established, incorporating National Institute for Rocket Research.
Estates Division becomes Estates Department.

1968 Scientific Liaison Office, Paris, established.

1969 CSIR's nutritional diseases research activities of the National Nutrition Research Institute incorporated in new, separate Medical Research Council, the remaining activities established as the National Food Research Institute.
Hydraulics Research Unit of NMERI transferred to Stellenbosch.
Research Vessel *Meiring Naudé* commissioned (launched in 1967).
Magnetic Observatory, Hermanus, incorporated into CSIR.
Opening of the CSIR-developed water reclamation plant in Windhoek.

1970 CSIR celebrates its 25th anniversary.

1971 Dr S Meiring Naudé, President, retires and is succeeded by Dr Chris van der Merwe Brink.
National Electrical Engineering Research Institute established.

1972 SA Astronomical Observatory established at Sutherland.

1973 Agreement with Centre National d'Etudes Spatiales for operation of French satellite tracking station, Paardefontein.
Chemical Engineering Research Group becomes an independent entity.

1974 National Research Institute for Oceanology established.

1975 SA Paint Research Institute closed.
Scientific Liaison Office, Teheran, established.
Co-operative Scientific Programmes established as separate unit.
Centre for Scientific and Technical Information under Information and Research Services formed.
Production Engineering Advisory Services under TSD formed.

1976 NIRR renamed National Institute for Transport and Road Research.
Timber Research Unit becomes National Timber Research Institute.

1977 National Accelerator Centre established.
CSIR Conference Centre commissioned.

1978 National Institute for Aeronautics and Systems Technology established.
Satellite Remote Sensing Centre (under NITR) and Radio Astronomy Observatory established, both at Hartebeesthoek.

1979 Centre for Computing Services becomes a separate institute.

1980 Dr Chris van der Merwe Brink, President, dies, and Dr Chris Garbers appointed President.
CSTI becomes separate national institute.
CSIR becomes responsible for Fuel Research Institute.
National Calibration Service within NPRL established.
Scientific Liaison Office, Los Angeles, established.

1983 Laboratory for Molecular and Cell Biology established.
National Institute for Materials Research established.

1984 Fuel Research Institute incorporated into CSIR and renamed National Institute for Coal Research.
CSTI and CCS combine to form National Institute for Informatics.
Foundation for Research Development established from merger of Co-operative Scientific Programmes and Research Grant Division.

1985 Wits Nuclear Science Unit renamed The Wits/CSIR Schonland Research Centre for Nuclear Sciences.
National Institute for Personnel Research transferred to Human Sciences Research Council.

National Accelerator Centre at Faure officially opened.
Review of CSIR mission following the publication of the Government's White Paper on *Industrial Development Strategy*.
Dr Brian Clark appointed Deputy President, effective as from 1 January 1986.
CSIR liaison office in Los Angeles closed.
The CSIR signs a contract for designing and constructing a Lightning Research Station in Brazil.
The CSIR Printed Circuit Facility is closed down.
Official opening of the Non-Destructive Testing Laboratory at the Mine Equipment Research Unit at Cottesloe and the Fluidised-Bed Combustion Pilot Facility at Pretoria West.
Shark repellent cable laid at Margate, Natal.

1986 Chemical Engineering Research Group becomes National Institute for Chemical Engineering Research.
Appointment of management consultants to advise on restructuring the CSIR.
Announcement of strategy for a future course of the CSIR.
CSIR publishes Wind Energy Atlas.

1987 National Building Research Institute's Regional Office in Port Elizabeth closed down and a new one opened in Sandton, Transvaal.
FRD publishes two Red Data Books, one on Endangered Species of Mammals and the other on Endangered Fish.
CSIR Technology Innovation Fund launched.
Work starts on new FRD building.
Coal dust explosion tunnel test facility operational at Kloppersbos near Pretoria.
Implementation of strategy for future course of CSIR begins.
Research Council Act and Inventions Development Act amended.
Top management of restructured CSIR appointed.
Directors to head new divisions report for orientation and planning.
First edition of *Technology Impact* published.
National Accelerator Centre at Faure delivers the first isotopes.
Impact roller developed by the CSIR exported to Australia.

1988 Restructured CSIR becomes operational: 27 Institutes formed into 12 Divisions.
New logo for CSIR.
National Institute for Telecommunications Research closed down.

Saidcor celebrates 25th anniversary.
Three CSIR activities are privatised, namely the Applied Chemistry Unit, the Mechanical Design Office and Transport Services.
Appointment of Dr Louw Alberts as Chairman of CSIR Board.
CSIR Laboratory for Molecular Cell Biology taken over by industry.
The CSIR Shark Deterrent Project terminated.
20th birthday of Research Vessel *Meiring Naudé*.
CSIR's Pretoria Cyclotron closed after 30 years.
CSIR sells its ownership of the high energy density battery to Anglo-American.

1989 The housing project on the Comores Islands successfully completed.
The Division of Building Technology's three regional offices in Durban, Cape Town and Sandton closed down.
First cancer patients treated at the National Accelerator Centre at Faure.
FRD building officially opened.
Magnetic Observatory at Hermanus transferred from the Research, Development and Implementation Group to the control of FRD.
Chemdata, the CSIR Chemical Guide published.
New medium-speed wind tunnel commissioned.
Division of Processing and Chemical Manufacturing closed down and activities transferred to other divisions.
CSIR's overseas offices transferred from FRD to the RDI Group.
Consolidation of all CSIR activities in the Western Cape at Stellenbosch.
New facilities for testing mine cable at Cottesloe commissioned.
RV *Meiring Naudé* sold.
Division of Energy Technology moves from Lynnwood Road to CSIR main campus.

1990 CSIR Club established.
Sciendaba celebrates 25th anniversary.
The CSIR signs contracts for R11 million with the National Energy Council.
Staff of the South African Forestry Research Institute transferred to the CSIR.
The Division of Textile Technology established with headquarters in Port Elizabeth and Mr Jan Becker as Director.

Book on CSIR history, *CSIR – The First 40 Years* by DG Kingwill published and distributed.
Division of Forest Science and Technology established with Dr Fred Kruger as director.
Dr Chris Garbers, President, retires and is succeeded by Dr Brian Clark.
FRD becomes independent council with Dr Reinard Arndt as its first President.

1991 The CSIR recognises the National Education, Health and Allied Workers Union.
Magnetic Observatory at Hermanus transferred back to the CSIR from FRD.
The CSIR quarterly journal *Scientiae* published for the last time, to be replaced by a monthly tabloid *Technobrief*.
International agreement on measuring standards signed with the Industrial Technologies Research Institute of the Republic of China (Taiwan).
National facilities NAC, SAAO and RAO transferred to FRD.
The CSIR's Paris office closed down.
The CSIR obtains a three-star safety award by the National Occupational Safety Association on its first attempt for a rating.
CSIR achieves a technological first in the gold jewellery manufacturing industry.
A delegation from the ANC, led by Mr Nelson Mandela visits the CSIR.
Sir Basil Schonland, first president of the CSIR, honoured by the issue of a commemorative postage stamp.
Opening of the staff housing project, *Entabeni*, on the main campus.
The National Calibration Service attains recognition in Europe.
The CSIR develops a two-seater fixed wing aircraft, named *OVID*, later renamed *ACE*.

1992 The CSIR Policy Unit established with Dr G de Wet as Director.
The CSIR's Computer Virus Protection System enters the market.
A composite carbon fibre wheel for racing motorcycles developed.
The CSIR signs contracts for participation in the Lesotho Highlands Water Project.
The CSIR awarded the 1991 Technology Top 100 Prize.
CSIR Fellowship scheme launched with Dr PS Steyn as the first CSIR Fellow.

Division of Manufacturing and Aeronautical Systems Technology established from previous Aeronautical Systems Technology and Production Technology divisions with Dr JTD Fritz as director.
The CSIR is awarded a four-star safety rating by NOSA.

1993 The CSIR new pension fund is launched.
COMRO merged with CSIR to form Division of Mining Technology.
The CSIR-developed twin seater observation aircraft *Hummingbird* takes to the air.
Co-operation agreement signed between the CSIR and the Laboratorio Tecnologica del Uruguay.
The CSIR signs a contract with the California Department of Transportation to supply two heavy vehicle simulators and a five-year technology transfer project.
New edition of *Chemdata* published.
CSIR's remaining overseas liaison offices (London, Bonn and Washington) closed and International Relations Unit established in Pretoria with Dr R Biesenbach as manager.
The CSIR's Forestry Research Centre in Sabie transferred to Nelspruit.
The CSIR-developed abalone hatchery established at Hermanus.

1994 Launch of Supertag™, a revolutionary electronic identification system.
SA National Calibration Service becomes independent body.
Privatisation of the CSIR's glass-blowing facility, shop and stationery store.
Agreement signed with the Centre Nationale d'Etudes Spatiales, the French space agency.
New pollution monitoring laboratory at Cape Point completed.
Division of Energy Technology closed, activities redeployed.
New CSIR Fellows appointed, W Botha, Prof F Nabarro, Dr Bob Scholes and Dr Francois Anderson.
The Division of Materials Science and Technology awarded the 1994 Innovation Award of the SA Institute of Chemical Engineers.

1995 Dr Brian Clark resigns from the CSIR, effective 1 April, to take up the position of MD and CEO of Telkom.
Fishing Industries Research Institute merged with the Division of Food Science and Technology.
The 75-ton magnet of the Pretoria Cyclotron transferred to the National Accelerator Centre, Faure.

50th anniversary of CSIR, commemorative postage stamp issued to mark the event.
Announcement of consolidation of divisions of Earth, Marine and Atmospheric Science and Technology, Forest Science and Technology and Water Technology and Corporate Environmental Services into a new Division of Water, Environment and Forestry Technology to become operative in 1996 with Mr A Yannakou as Director.
New Board appointed with Dr Bill Venter as Chairman.
Dr Geoff Garrett appointed as President, effective 1 December 1995, having served as Acting President since June 1995.

Notes

PROLOGUE

1. The term 'ancient man' is used loosely to denote the predecessors of modern man, in this case *Homo habilis*. The term 'man' and the pronoun 'he' is used throughout this book to denote its traditional meaning of 'mankind' or 'person' without any sexist intent.
2. Clarke, James. Mining: From Digging to Dynamite, *Mining Survey*, No 1, 1989, p. 35.
3. Tobias, Phillip quoted in Quest for Fire , *Leadership*, Vol. 13, No 3, 1994, p. 94 by Ebersohn, Wessel. (Professor Tobias, has retired as professor of anatomy at the University of the Witwatersrand, but still heads its Palaeo-Anthropology Research Unit (PARU).)
4. Unesco, *World Science Report*, February 1994.
5. The IDRC study was commissioned by the ANC, COSATU and SANCO in the early 1990s and was sponsored by the International Development Research Centre (IDRC) of Canada. The final report *Towards a Science and Technology Policy for a Democratic South Africa*, appeared in July 1993.
6. For an in-depth history of the CSIR up to 1985, consult *The CSIR – the First 40 Years* by DG Kingwill.

CHAPTER 1

1. Brain, CK and Sillen, A. Evidence from the Swartkrans cave for the earliest use of fire, *Nature*, Vol.336, 1988, pp 464-466.
2. Boshier, A and Beaumont, P. Mining in Southern Africa and the emergence of modern man, *Optima*, Vol. 22, 1972, p. 2.
3. Clarke, James. Mining: from Digging to Dynamite, *Mining Survey*, No 1 1989, p. 35.
4. Boshier and Beaumont Ibid. p. 2.
5. A pointed wedge-like tool used by miners.

6. Beaumont, PB, The ancient pigment mines of Southern Africa, *S A Journal of Science*, Vol. 69, 1973, p. 141.
7. Beaumont, Ibid, p. 146.
8. Deacon, J. Later Stone Age people and their descendants in southern Africa, in Klein, R G (ed.) *Southern African Prehistory and Paleoenvironments*, 1984, p. 221.
9. Inskeep, RR, *The Peopling of Southern Africa*, 1978, p. 118.
10. Maggs, Tim, The Iron Age South of the Zambezi, in Klein, RG (Ed.), *Southern African Prehistory and Paleoenvironments*, 1984, p. 343.
11. Maggs, Ibid, p. 350.
12. Huffman, TN and Vogel, JC, The Chronology of Great Zimbabwe, *SA Journal of Science*, Vol. 46, 1991, p. 61-70.
13. Maggs, Ibid, p. 351-353.
14. Maggs, Ibid, p. 341.
15. Maggs, Ibid, p. 357.
16. Boshier and Beaumont, Ibid, p. 12.
17. Cowey, A, *Mining and Metallurgy in South Africa - a pictorial history*, Published by Mintek, 1994.
18. Evers, TM and van der Berg RP, Ancient mining in Southern Africa, *Journal of the SA Institute of Mining and Metallurgy*, Vol. 74, No 6, January 1974, p. 226.
19. Mason, RJ, Background to the Transvaal Iron Age - new discoveries at Olifantspoort and Broederstroom, *Journal of the SA Institute of Mining and Metallurgy*, Vol. 74, No 6, 1974, p. 211.
20. Inskeep, RR Ibid, p. 153.
21. Boucher, Maurice, The Cape under the Dutch East India Company in *An Illustrated History of South Africa*, Ed. Cameron, Trewhella, 1986, p. 70.
22. Du Bruyn, JT, The Great Trek in *An Illustrated History of South Africa*, Ibid, p.134.
23. Jeppe, C Biccard, *Gold Mining on the Witwatersrand*, published by the Transvaal Chamber of Mines, 1946, pp. 1-2.
24. Ibid, p. 2.
25. Ibid, p. 3.
26. Ibid, p. 4
27. Ibid, p. 5.
28. Ibid, pp. 6-7.
29. Ibid, p. 7.
30. Hanisch, EOM, Copper working in the Messina district, *Journal of the South African Institute of Mining and Metallurgy*, Vol.74, No 6, 1974, pp. 250-251.
31. Jeppe Ibid, p. 8.
32. Ibid, pp. 8-9.
33. Ibid, pp. 22-23.
34. Talbot, WJ, Pathfinders and Pioneers, Explorers and Scientists 1487-1976, in Brown, A C (Ed.) *A History of Scientific Endeavour in South Africa*, published by the Royal Society of South Africa, 1977 p. 4.
35. The South African Society for the Advancement of Science in 1902 and the South African Medical Society in 1906.
36. Naudé, SM and Brown AC: The Growth of Scientific Institutions in South Africa, in Brown Ibid, p.69.
37. Dr HJ van der Bijl was a South African scientist renowned for his research in the new field of electronic engineering. He gave up a brilliant career in the USA to take up the post as head of the Division of Industries of the Department of Mines and Industries

in 1919 while at the same time serving as Scientific and Technical Adviser to the Government.

CHAPTER 2

1. Dr Basil Schonland was a professor of geophysics and director of the Bernard Price Institute of Geophysical Research at the University of the Witwatersrand. He had earned an international reputation for his research on lightning.
2. Royal Society. *Biographical Memoirs of Fellows of the Royal Society*. London. Vol. 19. 1973. p.642.
3. Kingwill, DG. *The CSIR – the First 40 Years*. published by the CSIR. 1990. p 8.
4. Ibid. p. 9.
5. Ibid. p. 10.
6. The names of members of the first council are listed at the back.
7. CSIR. *The Objects and Policy of the South African Council for Scientific and Industrial Research – An initial Statement*. Pretoria. 1945 as quoted in Kingwill DG. *The CSIR – the First 40 Years*. 1990. p 13.
8. Ibid.
9. Naudé and Brown in Brown Ibid. p. 77.
10. Personal communication by Margaret Nabarro, who was Dr Schonland's secretary during World War II at the Operations Research Group in London.
11. *Optima*. Oct 1986. pp 136-139.
12. Dr Brink had been a professor in organic chemistry at the University of the Orange Free State before being appointed to the CSIR as vice-president in 1968.
13. NASA: National Aeronautical and Space Administration, of the United States of America.
14. CNES: Centre Nationale d'Etudes Spatiales, space agency of the French Government.
15. Dr Hodgson was director of the CSIR's Technical Services Department from 1972- 1984.
16. Dr Richard (Dick) Turner, head of the National Measuring Standards activity at the CSIR 1970-1993. After his retirement at the end of 1993, he became head of the newly independent National Calibration Service.

CHAPTER 3

1. Dr James Brian Clark became the sixth president of the CSIR in 1990 and presided in this capacity until 31 March 1995 when he became the MD and CEO of Telkom. At the age of 41 he was the youngest president ever appointed to this position. He was pivotal to the transformation the CSIR underwent in the 1980s and 1990s.
2. Cullings, John, Young Blood, *Leadership*, Vol. 9, Dec./Jan. 1990/91 p 62.
3. Dr Eric Halliday, one of the first researchers appointed at the CSIR. He was responsible for setting up the country's national measuring standards and a pioneer of air pollution research in South Africa.
4. *Sciendaba*. Vol 31, No 9, 18 June 1993, p 3.
5. Dr George J Ritter pioneered laser research in South Africa on return from an extensive post doctoral stint at the National Research Council of Canada.
6. Wilkinson, MM: Report: *A Summary of the CSIR Change Process from Values to Culture*. Human Resources Services, 23 Sept 1991.
7. Ibid.
8. Armscor is the official armaments procurement agency for the national defence force.
9. The endless frontier concept was coined by Dr Vannevar Bush in his report to President Franklin D Roosevelt entitled *Science – the Endless Frontier*, published in July 1945 in response to Roosevelt's request to draw lessons from the wartime experience that could

be applied in the coming peace. He based the title on a sentence taken from Roosevelt's letter to him: 'New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness, and drive with which we have waged this war we can create a fuller and more fruitful employment and a fuller and more fruitful life'. Bush was Director of the Office of Scientific and Research and Development at the time.

CHAPTER 4

1. The Riekert Commission looked at legislation that was specifically discriminatory and the Wiehahn Commission looked into the normalising of the trade unions.
2. Professor JS de Wet, former dean of the Faculty of Science at the University of Cape Town. He retired in 1982, after which he spent some time at the CSIR before leaving for England. He was a Supernumerary Fellow and Emeritus Fellow of Balliol College, Oxford University. Professor de Wet passed away in January 1995 in the UK.
3. Dr Sebastiaan Kleu, Chairman of the Council for Trade and Industry and professor of Economics and Commerce at RAU.
4. Dr Arndt was professor of organic chemistry at the University of Stellenbosch before his appointment to the CSIR as vice-president in 1981.
5. '... that the CSIR, in co-operation with the Department of Trade and Industry, should take the lead in establishing an appropriate mechanism for the transfer of technology.' White Paper on *Industrial Development Strategy*, published in May 1985.
6. Among them were Dr MT de Waal (Industrial Development Corporation), Dr JH Visser (National Productivity Institute), Prof. R Marcus, a vocal critic of the CSIR (University of the Witwatersrand), Mr R Mason (FedMech and SEIFSA representative), and Dr C Donninger (a consultant, who submitted a written contribution). The open session was also attended by Dr SJ Kleu (Chairman of the Council for Trade and Industry and professor of Economics and Commerce at RAU) and Dr W Schütte (Department of Trade and Industry). Dr DJ Gouws (ex-director of the CSIR's National Personnel Research Institute) acted as facilitator.
7. *Bosberaad*: Afrikaans term given to the practice of going into seclusion, preferably in rural surroundings, for intensive discussions.
8. Clark, JB: Report: *The Management Structure of the CSIR*, December 1985.

CHAPTER 5

1. Kingwill, DG, The CSIR – the First 40 Years, 1990 p 40.
2. The task group consisted of Dr JB Clark and Chief Directors Dr MS Hunt, Dr DF Toerien, Dr JSV van Zijl, Dr TJ Hugo, Dr GG Garrett and Dr DH Martin.
3. The primary definition of the role of the CSIR is embodied in the Scientific Research Council Act, 1984 (Act 82 of 1984).
4. Professor Louis van Biljon was the Head of the Department of Electronic Engineering at the University of Pretoria at the time. He later became Dean of the Faculty of Engineering.
5. Dr Charles Boyce is considered to be the father of electronics in South Africa; Prof. Christo Viljoen was conducting a study into the microelectronics industry in South Africa for the Department of Trade and Industry; Mr P Meerholz had to decline the invitation.

CHAPTER 6

1. Core mission statement: The CSIR undertakes, fosters and manages broadly based scientific research, development and technology transfer in support of and to meet the needs of South African industry, community interests and quality of life in a cost ef-

fective manner. We strive for excellence.

2. Porras, JL. Stream Analysis: *A Powerful Way to Diagnose and Manage Organizational Change*. 1987. Addison-Wesley. Reading. Massachusetts.
3. Act 46 of 1988. 'The objects of the CSIR are, through directed and particularly multidisciplinary research and technological innovation, to foster, in the national interest and in fields which in its opinion should receive preference, industrial and scientific development, either by itself or in co-operation with principals from the private or public sectors, and thereby to contribute to the quality of life of the people of the Republic, and to perform any other functions that may be assigned to the CSIR by or under this Act.'
4. Mintek is a national science council in the field of mineral technology.
5. Mitton, Simon, *Science Watch*, Vol. 6 No 3, March 1995, p. 1.
6. The Inventions Development Act (Act No 31 of 1962) was mandated to act not only for the CSIR, but also for government departments, public bodies, universities, industrial firms and private inventors. The first board of directors consisted of Dr SM Naudé (chairman), Mr GSJ Kuschke, Mr D Lion-Cachet, Dr PE Rousseau and Dr N Stutterheim (alternate: Mr DG Kingwill). Examples of its success in industrialising and commercialising local inventions are the tellurometer system, improved process for preparation of gamma globulin for immunisation, the Bardenpho system for liquid effluent treatment, the advanced Scheffel bogie, the bollard and toggle (carbon fibre surgical implants), an impact roller for soil compaction and many more.

CHAPTER 7

1. A Deputy President and six Chief Directors.
2. Professor WO Prozesky, the current President of the Medical Research Council, was a council member at the time of the CSIR's restructuring.
3. Dr H Booyens is a physicist who served for several years as business development manager of the Division of Microelectronics and Communications Technology and is currently programme manager of the Division's Logistics Engineering Technology. The Division was renamed the Division of Communications and Information Networking Technology in 1995.
4. The names of past recipients since an award system was introduced in the CSIR are listed at the back.
5. Dr Tony Pizzi, director of the division and a recipient of one of the CSIR's prestigious merit awards in 1985.
6. Research Development Act (Act No 75 of 1990).
7. Dr Arndt has since retired and has been succeeded by Dr Khotso Mokhele.
8. Wilkinson, MM, Reports to Executive: *Value Surveys*, dated February, September and November 1991.

CHAPTER 8

1. London 1946-1993, Washington 1946-1993, Cologne/later Bonn 1957-1993, Paris 1968-1991, Teheran 1975-1979, Los Angeles 1981-1985.
2. Segal, Quince, Wicksteed of Cambridge, UK.

CHAPTER 9

1. International members: Sir Herman Bondi, UK, Chairman of the Board, International Federation of Institutes of Advanced Study; Mr James Mullin, Canada, Mission Leader; Dr Deanna Ashley, Jamaica; Dr Geoffrey Oldham CBE, UK. South African mem-

bers: Dr Frene Ginwala, ANC Research Department; Dr David Kaplan, University of Cape Town; Dr Ivy Matsepe-Casaburri, Education Trust for South Africa. In total representatives from some 34 local science and technology and education-related bodies contributed to the study.

2. The concept 'appropriate technologies' is used in its broadest sense to mean whatever technology is appropriate for the current national situation, ranging from cutting-edge fundamental research necessary for the economy to the humblest of pragmatic applications such as pedal powering of weaving looms until electricity becomes available.
3. Maister, David, *Managing the Professional Services Firm*, Free Press, New York, 1993.
4. Wood, Robert L, Affirmative Reaction, *Leadership*, Vol. 14 No 2 1995 pp 88-91.
5. Kanter, Rosabeth Moss, *The Change Masters*, Simon & Schuster, Inc. New York, First Touchstone Edition 1984, p. 18.

CHAPTER 10

1. Segal, Quince, Wicksteed of Cambridge, United Kingdom.
2. The Department of Arts, Culture, Science and Technology has assumed responsibility for science and technology, a function of the previous Department of National Education.
3. Professor MW Makgoba is a former Deputy Vice-Chancellor (Academic) of the University of the Witwatersrand, and current Chairman of the Boards of the Medical Research Council of South Africa and the National Accelerator Centre, the latter being part of the Foundation for Research Development.
4. Dr John Temple is Chief Executive of Plescorp, the new holding company created out of the merger of Plessey and Tek Corporation. Dr Temple had been Group Managing Director of Plessey Tellumat South Africa since 1985 until the recent merger.
5. Dr Khotso Mokhele, a vice-president (at the time) of the Foundation for Research Development responsible for Science and Technology Ethos, gave the address at the Conference on Sub-Regional Science and Technology Collaboration in Southern Africa held at Roode-vallei Country Lodge on 5 December 1994. He has since succeeded Dr Arndt as president.
6. Roussel, PA, Saad, KN and Erickson, TJ, *Third Generation R&D: Managing the Link to Corporate Strategy*, Harvard Business School Press, Boston, 1991.
7. Hamel, Gary and Prahalad, CK, Strategy and Intent, *Harvard Business Review*, 1989.
8. An expression used in RN Foster's book, *Innovation: The Attacker's Advantage* (MacMillan, London, 1986) to describe the philosophy of concentrating scientists in campus-like surroundings to provide a favourable environment for innovative research.
9. Van Vliet, B, CSIR 50th Anniversary - Reflections and Projections, June 1995 (unpublished essay).
10. Mokhele, Khotso, Graduation Address, University of Cape Town, 7 December 1994.
11. Clark, JB and de Wet, G: New frontiers for science and technology in South Africa: a platform for change, *SA Journal of Science*, Vol 91, March 1995, p. 116.
12. Ibid p. 116.
13. *Business Week International*, R&D Scoreboard, 28 June 1993, pp 54-57.
14. Van Vliet, Ibid. The foregoing paragraphs under the title Future were extracted from Van Vliet's essay.

PROFILES

1. The quotation is attributed to a British MP who hailed from the dockyards. He once at-

tended a meeting where speeches abounded with Latin tags, for which he had little use and made up his own quotation as a counter.

CHRONOLOGY OF KEY EVENTS

1. For a more detailed account of events from 1945-1985 *see* DG Kingwill, *The CSIR – the First 40 Years*.

Bibliography

Books

Brown, AC (ed.), *A History of Scientific Endeavour in South Africa*, The Royal Society of South Africa, Cape Town, 1977.

Cameron, Trewhella (ed.), *An Illustrated History of South Africa*, Reader's Digest, Cape Town, 1986.

Cowey, A, *Mining and Metallurgy in South Africa: A Pictorial History*, Mintek, Johannesburg, 1994.

Davenport, THD, *South Africa: A Modern History*, 3rd edn, Macmillan South Africa, Johannesburg, 1987.

Foster, RN, *Innovation: The Attacker's Advantage*, Macmillan, London, 1986.

Hall, Martin, *The Changing Past: Farmers, Kings and Traders in Southern Africa, 200-1860*, David Philip, Cape Town, 1987.

Inskeep, RR, *The Peopling of Southern Africa*, David Philip, Cape Town, 1978.

Jeppe, C Biccard, *Gold Mining on the Witwatersrand*, Transvaal Chamber of Mines, Johannesburg, 1946.

Kanter, Rosabeth Moss, *The Change Masters*, Simon & Schuster, NewYork, first Touchstone edn, 1984.

Kingwill, DG, *The CSIR - The First 40 Years*, CSIR, Pretoria, 1990.

Klein, RG (ed.), *Southern African Prehistory and Paleoenvironments*, A A Balkema, Rotterdam, 1984.

MacLeod, Roy (ed.), *The Commonwealth of Science - ANZAAS and the Scientific Enterprise in Australasia 1888-1988*, Oxford University Press, New York, 1988.
Maister, David, *Managing the Professional Services Firm*, Free Press, New York, 1993.
Mandela, Nelson, *Long Walk to Freedom*, Macdonald Purnell, Johannesburg, 1994.
Maylam, Paul, *A History of the African People of South Africa: from the Early Iron Age to the 1970s*, David Philip, Cape Town, 1987.
Porras, JL, *Stream Analysis: A Powerful Way to Diagnose and Manage Organizational Change*, Addison-Wesley, Reading, Mass., 1987.
Roussel, PA, Saad, KN and Erickson, TJ, *Third Generation R&D: Managing the Link to Corporate Strategy*, Harvard Business School Press, Boston, Mass., 1991.
Royal Society, *Biographical Memoirs of Fellows of the Royal Society*, vol. 19, London, 1973.

ARTICLES

Beaumont, PB,The ancient pigment mines of Southern Africa, *SA Journal of Science*, vol. 69, 1973.
Boeyens, JCA, Wetenskap en Tegnologie, unpublished article, February 1994.
Boshier, A and Beaumont, PB, Mining in Southern Africa and the emergence of modern man, *Optima*, vol. 22, 1972.
Brain, CK & Sillen, A, Evidence from the Swartkrans cave for the earliest use of fire, *Nature*, vol. 336, 1988, pp. 464-6.
Bush, Vannevar, Science – The Endless Frontier, 1945, reprinted and published by the National Science Foundation, 1980.
Business Week International, R&D Scoreboard, 28 June 1993, pp. 54-7.
Clark, JB and de Wet, G, New frontiers for science and technology in South Africa: a platform for change, *SA Journal of Science*, vol. 91, March 1995.
Clarke, James, Mining: from digging to dynamite, *Mining Survey*, no. 1, 1989.
Cullings, John, Young blood, *Leadership*, vol. 9, Dec./Jan. 1990/91.
Ebersohn, Wessel, Quest for fire, *Leadership*, vol. 13, no. 3, 1994.
Evers, TM and van der Berg, RP, Ancient mining in Southern Africa, with reference to a copper mine in the Harmony Block, north-eastern Transvaal, *Journal of the SA Institute of Mining and Metallurgy*, vol. 74, no. 6, January 1974.
Hamel, Gary and Prahalad, CK, Strategy and intent, *Harvard Business Review*, 1989.
Hanisch, EOM, Copper working in the Messina district, *Journal of the South African Institute of Mining and Metallurgy*, vol. 74, no. 6, January 1974.

Huffman, TN and Vogel, JC. The chronology of Great Zimbabwe. *South African Journal of Science*, vol. 46, 1991, pp 61–70.
Mason, RJ: Background to the Transvaal Iron Age: new discoveries at Olifantspoort and Broederstroom. *Journal of the SA Institute of Mining and Metallurgy*, vol. 74, no 6, January 1974, p 211.
Mitton, Simon. *Science Watch*, vol. 6, no. 3, March 1995.
Mokhele, Khotso. Graduation Address, University of Cape Town, 7 December 1994.
Optima, October 1986.
Sciendaba, vol. 31, no. 9, 18 June 1993.
Wood, Robert L. Affirmative reaction. *Leadership*, vol. 14, no. 2, 1995.

REPORTS

Clark, JB. Report: *The Management Structure of the CSIR*, December 1985.
Council for Scientific and Industrial Research. *The Objects and Policy of the South African Council for Scientific and Industrial Research – An Initial Statement*, Pretoria, 1945.
IDRC. Report: *Towards a Science and Technology Policy for a Democratic South Africa*, July 1993.
Kleu, Sebastiaan. *White Paper: Industrial Development Strategy*. Department of Trade and Industry, Pretoria, 1985.
UNESCO. *World Science Report*, February 1994.
Van Vliet, B. *CSIR 50th Anniversary: reflections and projections*, June 1995 (unpublished essay).
Wilkinson, MM. *Report: A Summary of the CSIR Change Process from Values to Culture*, Human Resources Services, 23 September 1991.

Index