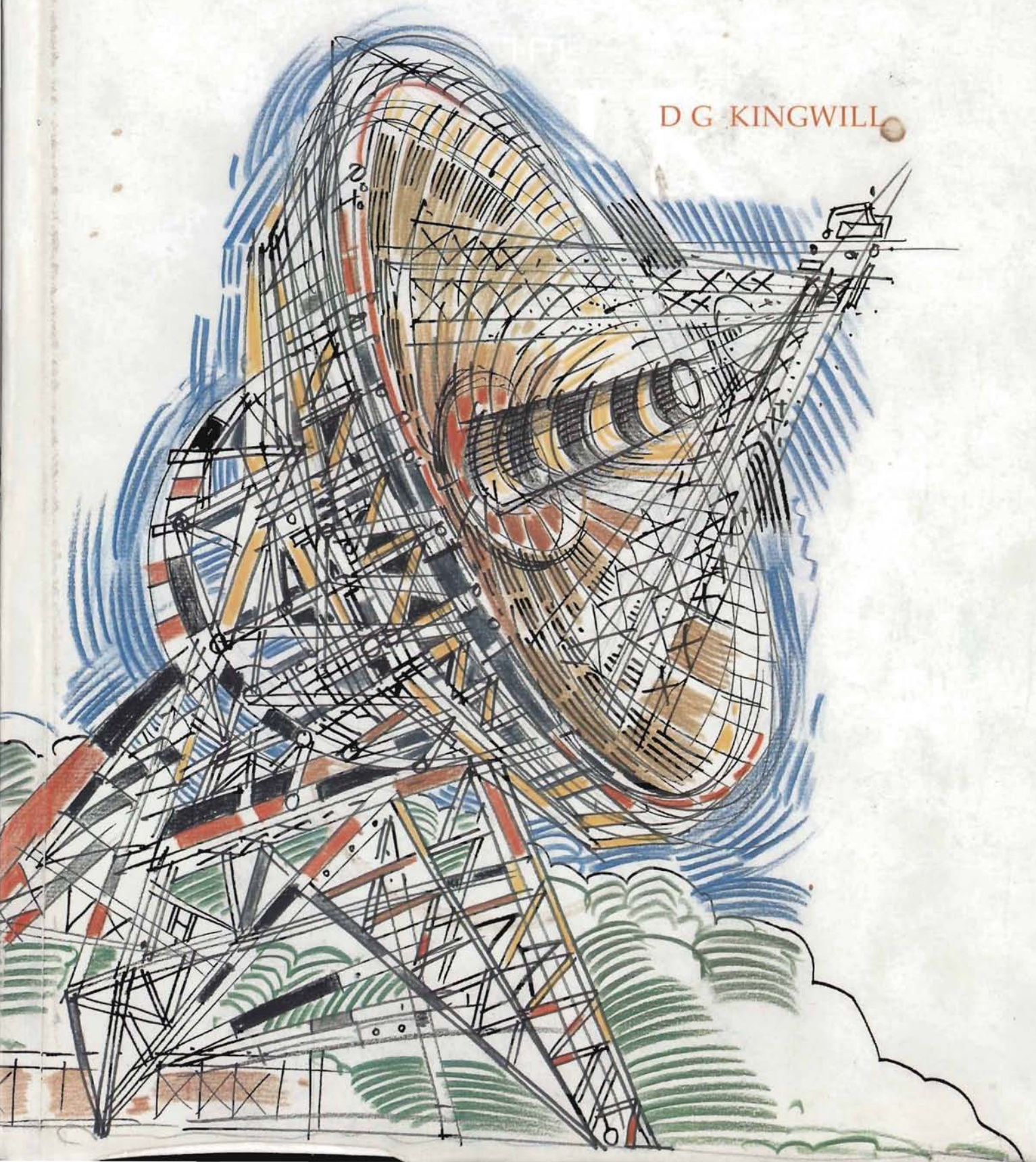


THE
CSIR
THE FIRST 40 YEARS

D G KINGWILL





THE AUTHOR

Denys Graham Kingwill, born in Graaff-Reinet in 1917, attended the Grey High School in Port Elizabeth and Rhodes University in Grahamstown. His student years were cut short by the outbreak of the Second World War in 1939. With an MSc degree in Physics he joined the Meteorological Section of the South African Air Force in February 1940. In South Africa he was in charge of the Forecasting Unit of 42 Air School, RAF, and Senior Meteorological Officer to 25 Group, RAF, in Port Elizabeth. In the Middle East he served as a forecaster attached to the Central Weather Forecasting Office of the RAF in Cairo and to Advanced Air Headquarters, Western Desert, and headed the first mobile weather forecasting unit attached to 3 Wing SAAF. In Italy he led the mobile weather forecasting unit attached to the RAF's Balkan Air Force operating from the east coast of Italy. He was mentioned in dispatches.

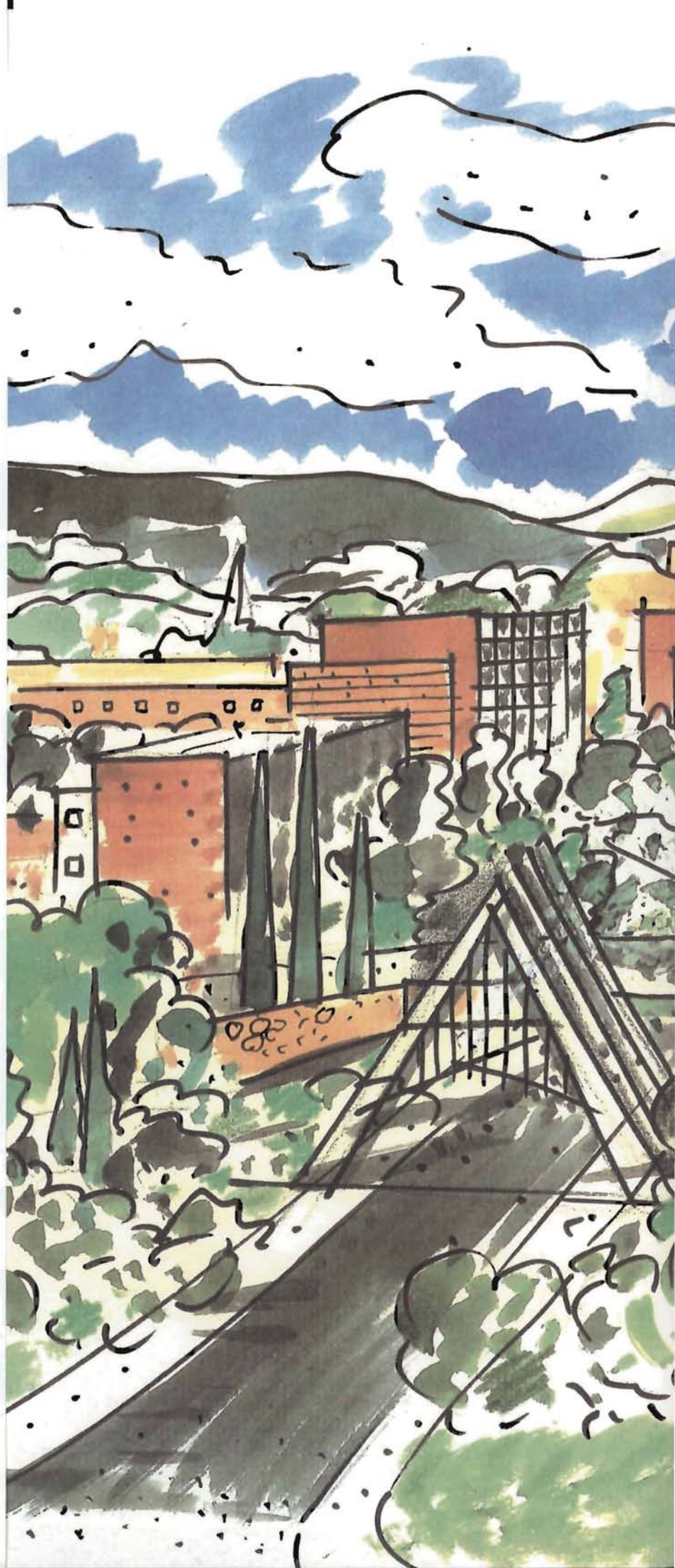
In July 1945 he was invited to join Dr B F J Schonland, CBE FRS, who at that time, as scientific adviser to the Prime Minister, was finalizing plans for the establishment of the CSIR for which legislation had been passed by Parliament in June of that year. As professional assistant he was intimately associated with all aspects of the establishment and development of the CSIR under Dr Schonland. He was most directly involved with the activities described in Part 2 of this book, and was Director of Information and Research Services from 1962 to 1983.

At university he was keenly interested in student affairs. A member of the First XV from his first year he became rugby captain in 1939, in which year he was also secretary of the Students Representative Council and chairman of the Debating Society.

At the CSIR he was dedicated to the advancement of science and technology in the public interest at both national and international level. In this context he attached particular importance to the role of scientific and technical societies and devoted much time and energy to these activities. In the South African Association for the Advancement of Science (S.A.A.S.) he was Chairman of the Conference Organizing Committee, Honourable General Secretary and, in 1982, President. He was a member of the Executive Committee of the National Library Advisory Council, Fellow of the Institute for Library and Information Science and after retiring was elected an Honorary Life Member. He was also a member of the Executive Committee of the Advisory Board of the Abstracting Board of the International Council of Scientific Unions (ICSU - AB). In 1981 he was President of the Associated Scientific and Technical Societies (AS & TS).

Having been intimately and actively involved in the founding and development of the CSIR, Denys Kingwill was eminently suited to undertake, at the request of the CSIR Executive, the task of documenting the history of the CSIR over its first 40 years. His retirement in 1983 coincided with initiatives for a necessary restructuring and change of course of the organization with which he had been so closely involved. This change of course was initiated in 1985, 40 years after the author, as the first appointed member of the CSIR's staff, became a partner in establishing the CSIR in 1945.

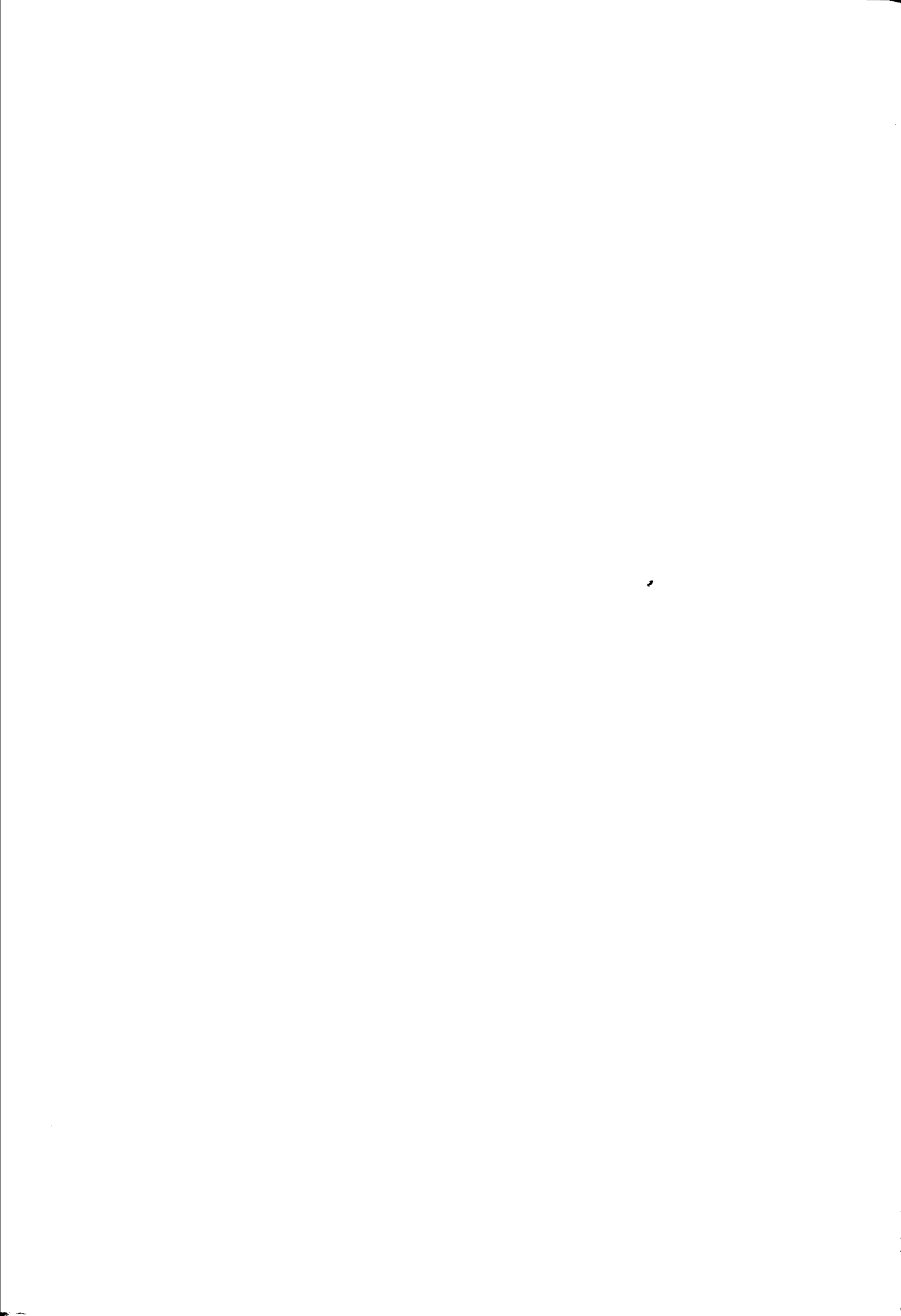
In recognition of the major role he had played in advancing science, technology and scientific and technical information in South Africa, he was awarded an Honorary Doctor's Degree in 1984 by the Rhodes University in Grahamstown.





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The CSIR — the first 40 years



The CSIR the first 40 years

D G Kingwill

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Artwork
Hannes Meiring

Dust jacket (front)
Radio astronomy antenna at
Hartebeesthoek (formerly used for
tracking NASA's deep space
explorer craft).

Dust jacket (back)
A telescope dome at the SAAO
observing station at Sutherland and
a satellite tracking antenna at
Hartebeesthoek.

Inside front cover
General view of CSIR.

Inside back cover
The CSIR Conference Centre.

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FOREWORD

This book is a tribute to the far-sightedness of legislators, to people with exceptional motivation and organizational skills and to generations of dedicated and talented scientists and engineers. The visionary step by General J C Smuts to create the Council for Scientific and Industrial Research (CSIR) in 1945, initiated a sequence of events which saw this institution grow from its modest beginnings to a giant in its class on the African continent, establishing for itself a worldwide reputation for excellence and achievement. Many of those who have contributed remain anonymous but can take pride in what has been achieved.

The CSIR is indeed fortunate to have Dr D G Kingwill to write this monograph. Not only was this meticulous man deeply involved with the CSIR from its inception in 1945, but he worked closely with successive presidents of the CSIR for 38 years. This, together with his exceptional memory and astounding talent for gathering, processing, ordering and presenting in digested form the massive relevant information, made him the ideal person to write this compendium of the CSIR's first 40 years. Great benefit was also derived from the oral and written submissions of many who contributed to the CSIR in its formative years.

No organization develops in isolation. Fulfilling a great need, the CSIR widely interacted with other bodies and was itself shaped in turn. By 1984 wide-ranging collaboration with 32 state departments, commissions, councils and boards, as well as with all universities, technikons and museums existed. A thousand bursaries were made available on merit for postgraduate study in science and engineering. Extensive international collaboration existed, including collaboration with 14 African countries. Many of the CSIR's operational units served one or more particular industrial sector and approximately 2 500 R & D contracts were undertaken annually on behalf of industry. In summary, the CSIR contributed extensively to the scientific and technological emancipation of South Africa.

However, throughout the world during the seventies and the eighties, the role and accountability of research laboratories, totally or partially funded by government was questioned, often associated with efforts by governments at more direct control. The CSIR was no exception. Under the guidance of its Council it adopted an approach to earn greater autonomy through greater market orientation and client participation, while remaining involved in research directed at South Africa's requirements.

Accepting the challenge as formulated in the White Paper on Industrial Development Strategy published in May 1985, viz. to assist South Africa's industry through effective technology development and transfer, the CSIR initiated an in-depth management review.

By 1 April 1988 the CSIR had implemented its previously announced change in course. The CSIR's two major functions were clearly delineated:

- as a technology-driven, market-oriented partner of South Africa's private and public sectors, and
- as sponsor for manpower and research development in science and engineering, predominantly at universities, technikons and museums.

For various reasons the publication of this book is opportune. The first 40 years concluded an era in the CSIR's history. Looking at the future, the CSIR had to restructure to ensure its sustained leadership role in the technology-driven era which the world is entering with its enhanced emphasis on creativity and competitiveness.

Indeed, the CSIR, intimately involved with the South Africa of the present, can build with confidence on the sound foundations of the past. With its accumulated know-how and 'Africa expertise' and with hopeful signs of greater pragmatism in our subcontinent, the CSIR, deeply conscious of its responsibilities to the community generally, looks forward with enthusiasm to its challenging future.

C F GARBERS

• President, CSIR
1990

PREFACE

This story of the first 40 years of the Council for Scientific and Industrial Research (CSIR) is presented in three parts. The first includes the events leading up to its establishment in 1945 and discusses the need for such a body in South Africa as seen against the background of world events, notably the impact of two world wars and the emergence in other countries of organizations with specific responsibilities for co-ordinating and developing scientific research. It continues as a chronological narrative of events which unavoidably is studded with names and dates.

The second part focuses on the role of the CSIR as a national research council in promoting and supporting university, medical and industrial research, fostering international scientific co-operation and in providing scientific and technical information services.

The development, organization and activities of the CSIR research laboratories, institutes and units, operating in this context as a 'contract research organization', are described in the third part.

When the CSIR was established in 1945, I was privileged to be one of the first members of staff in the new organization and to work with the many distinguished scientists and engineers who made outstanding contributions to science and technology in fields of particular relevance to the development of southern Africa. Those early years, when we were building up a new organization with such vast ramifications touching on all aspects of life and work in a rapidly developing region, abounded with stimulating challenges and opportunities.

I therefore gladly agreed to write the history of the first 40 years as a tribute to my former colleagues, many of whom willingly read and commented on the earlier drafts of this history and helped to verify specific facts and confirm the more general perspectives.

Without the willing and enthusiastic help of Mrs J P Bourne for the typing and retyping of many successive drafts, Mr P Pretorius, Mr G W B Stoop and Mrs M J Hingley for expert publishing services, Mrs E Shepherd and Miss J M Schoeman for careful archival reference work, and my wife, Mairi, for language editing and organizing of material, this History would never have been completed.

D G KINGWILL

PHOTOGRAPHS

The photographs in this book were selected from a collection accumulated over four decades. The author and the CSIR regrets that in the large majority of cases the identity of photographers is unknown. Therefore no attempt is being made to credit specific persons other than listing below the names of those known to have produced photographs for the CSIR from time to time. All these professionals are gratefully acknowledged herewith. To those of whom we have no record we offer our sincere appreciation and apologies.

Martin Gibbs
Allen Lipschitz
Marais Malan
Dotman Pretorius
Willie van Heerden
Cape Times Photographic Studio
Pretoria News
Beeld
CSIR Publicity Division Staff
Scientia Photo staff and
numerous members and
ex-members of CSIR personnel.

PART 1

Origin and growth

The years before 1945

Before the Union of South Africa came into being in 1910, research in this country was virtually limited to the sporadic efforts of gifted individuals in the museums and universities, and of distinguished visitors whose main purpose was to collect specimens for study in Europe.

However, it is worth remembering that the most important task of the first settlers at the Cape of Good Hope was to produce food, particularly fresh vegetables and fruit as a counter to scurvy, for the crews of the Dutch East India Company vessels on their long voyages to and from the Far East. In other words, the primary reason for the introduction of Western European culture into South Africa was to meet a combined agricultural and medical need – the provision of vitamin C!

While those early settlers were fortunate in that the climate at the south western tip of Africa was largely similar to that of the Mediterranean region, they nevertheless encountered many problems which were unfamiliar, such as endemic plant, animal and human diseases. As they and their successors penetrated further into the interior, they came across other difficulties associated with the African environment – steep mountain ranges, droughts alternating with floods, and clashes with warlike peoples.

However, they also found a rich, varied and unusual fauna and flora, rich mineral deposits, and later plant, animal and hominid fossil remains of a unique richness and variety, all of which provided a happy hunting ground for visiting scientists. Although, as has been said, they came at first mainly to collect specimens for study elsewhere, the late 19th and early 20th century saw the establishment of schools, then universities and museums, and eventually scientific societies which constituted the seed beds from which science in South Africa has grown.

The first permanent scientific institute to be established in South Africa was the Royal Observatory in Cape Town in 1820. Although its primary task involved marine navigation, which included the provision of a time service, it provided a base for the study of the southern skies. The Royal Observatory also played a key role in establishing the basis for a geodetic survey of southern Africa. Carrying on the work started by the Abbé de la Caille as early as 1752 and continued later by Sir Thomas Maclear and the Royal Engineers under Captain Bailey, Sir David Gill, head of the Royal Observa-

*The first permanent
scientific institute*

tory from 1879 to 1907, became the guiding spirit in planning a grid system of chains of geodetic triangulation for southern Africa and further north.

After 1910, when the former Republics of the Transvaal and of the Orange Free State joined the British Colonies of the Cape of Good Hope and Natal to form the Union of South Africa, the Government played an increasingly significant role in the development of organized research and in providing scientific and technical services.

The Department of Lands and Irrigation became responsible for a Meteorological Office which had developed from a meteorological survey initiated by the Transvaal Observatory. This observatory, established in Johannesburg in 1908, became the Union Observatory in 1910 and, in addition to astronomical research, provided the national time service. The department also established a hydrological survey, made important contributions to the design and development of dams and irrigation schemes, and in 1919 became responsible for a trigonometrical survey. This survey established a system of triangulation – primary, secondary and tertiary – covering virtually the whole country, and a network of permanent beacons which provided a solid foundation for cadastral, topographic and other work. In 1938 it assumed control of the Magnetic Observatory in Cape Town (moved to Hermanus in 1941).

First geological map

The first major contribution to the systematic mapping of the geology of South Africa was undertaken by Andrew Geddes Bain, a roads engineer with a passion for geology who was responsible for the publication of the first geological map of the southern Cape in 1856. The Geological Survey of the Union of South Africa was established under the Department of Mines in 1912. Its main functions were to provide geological and mineralogical services, including the preparation of geological maps of the Union and South West Africa as a scientific basis for mineral exploration. As an indication of the high professional standing of the staff, it can be mentioned that three of them, A L Hall, Alex L du Toit and S H Haughton, were elected Fellows of the Royal Society of London. The Department of Mines also established a Government Minerals Laboratory at the University of the Witwatersrand. In 1944 this was superseded by the Government Metallurgical Laboratory, which carried out research on extraction metallurgy for the beneficiation of minerals other than diamonds and coal. In addition, the Department of Mines was responsible for running the Government Mechanical Laboratory in Johannesburg under the Government Mining Engineer and a Silicosis Medical Bureau.

By 1945 the Department of Agriculture was conducting research through nine divisions. These included the world-famous Veterinary Research Institute at Onderstepoort, research institutes of the faculties of agriculture at the Universities of Natal and Pretoria, the Elsenburg College of Agriculture attached to the University of Stellenbosch, and the Citrus and Sub-Tropical Fruit Research Station at Nelspruit in the Transvaal Lowveld.

A vigorous programme of afforestation was successfully carried out by the Government, based on silvicultural research related to the introduction of fast-growing exotic softwoods and hardwoods in South Africa.

A Forest Products Research Institute was developed by the Department for the investigation of all problems connected with the seasoning, treatment and use of indigenous timbers and of locally grown exotic species. As the only establishment of its kind in Africa, it rendered assistance not only to local bodies but also to public and private concerns throughout the African continent.

Under the Department of Commerce and Industry, the Fuel Research Institute, with headquarters and laboratories in Pretoria, was established as an autonomous statutory body in 1930. Its task was to study the fuel resources of the country; to undertake scientific and technical research on fuels and their by-products, and be responsible for the grading of coals for export or bunkering. The finances of the Institute were derived from a levy on coal sold during the preceding year together with a *pro rata* subsidy from the Government. In 1932 a Division of Sea Fisheries was established by the same department to extend the marine biological survey initiated by Prof. J F Gilchrist of the University of Cape Town; its main purpose was to provide a scientific basis for regulating the exploitation of marine resources.

In a land of vast horizons, where population centres were, and still are, separated by great distances, transport and communication systems played a crucial role in the opening up and development of the country. The creak and groan of the tented oxwagon gradually gave way to the iron horse technology of the railways in the late 19th century. Then came the motor car, with an accompanying demand for improved road systems, and aircraft. By 1940, the South African Railways and Harbours Administration (SAR & H) included the South African Airways, but the development of these services is a saga in its own right. A National Roads Board had been established and had made good progress in developing a national roads network. These bodies reported to Parliament through the Minister of Transport. Communications, under the Department of Posts and Telegraphs, had also been transformed by technological developments – first telegraphy, then the telephone and later radio. By 1940 the South African Broadcasting Corporation was also well established. In addition, an Electricity Supply Commission (which later took over the Victoria Falls and Transvaal Power Company) had been established and the first steps taken towards the development of a national electricity supply network.

The foundation for medical research was laid for the first time in South Africa with the establishment in 1912 of the South African Institute for Medical Research (SAIMR) in Johannesburg. This institution was founded jointly by the mining industry and a somewhat reluctant government which contributed only the land and a small annual grant. Its establishment was prompted largely by the high morbidity and mortality rate among black mineworkers, mainly from infections and dust related diseases. However, the intention was that the SAIMR should serve the entire population and conduct research into all major health problems in the region – a policy which, in fact, it has followed ever since. Thus the SAIMR can be regarded as one of the private sector's first ventures, if not the first, into sponsored research in South Africa.

Fuel research

Medical research initiated

From what has been said it is clear that by the late 1930s an infrastructure for future development had been created by the Government. This included the provision of scientific and technical services and such organized research as there was. The private sector, too, was beginning to become involved in organized research. The mining industry, for example, in addition to its support (by now largely moral) for the SAIMR, maintained a Dust and Ventilation Department. Its task was to investigate the sources and nature of dust in the mines and to develop methods of controlling concentration of dust in the air – a field of research in which the SAIMR was also concerned. The Chamber of Mines also operated a Timber Research Laboratory to investigate the causes of decay of mine timbers and to develop suitable methods of preservation.

*Leather pioneers
industrial research*

The Leather Industries Research Institute, established in 1941 at Rhodes University College, Grahamstown, was one of the pioneers of organized industrial research in South Africa and by 1945 was making an effective contribution to the solution of problems affecting all aspects of the leather industry – from the processing of raw materials to the production of finished products such as footwear.

As early as 1925 the sugar industry established the Sugar Experiment Station at Mount Edgecombe in Natal which was entirely financed by the South African Sugar Association. Before this step was taken, the sugar industry had faced virtual extinction as a result of disease and the poor adaptation of the types of cane which had been introduced to the country since 1859.

Thus, in the 1930s, industrial research was beginning to emerge; but, whether in the government or private sector, this work was mostly oriented towards the production and processing of raw materials produced by the agricultural, silvicultural, mining and fishing industries. In other words, the general economic approach of South Africa at that time was very much that of a primary producer. What manufacturing industries there were, made use of proven technologies under licence to foreign companies, to produce finished consumer goods oriented towards import substitution in the local consumer market.

The most glaring shortcoming was, however, the lack of any effective government mechanism for the support, co-ordination and promotion of university and industrial research. Undoubtedly the Government's role in this sphere posed many problems. While the universities were fiercely protective of their autonomy, industry was committed to the principle of private enterprise and to the avoidance of any government intervention which might inhibit competition. To meet these requirements, some means had to be found which, while ensuring reasonable accountability for the expenditure of public funds, would at the same time be acceptable to both universities and industries.

*Government, industry
and science*

Efforts had been made to find an effective solution to this dilemma as early as 1916 when a joint meeting of scientific and technical societies formulated recommendations which resulted in the establishment by the Government of an Advisory Board for Industry and Science. Leading members of this

committee requested the appointment of a scientific head to the Division of Industries of the Department of Mines and Industries to give effect to its recommendations. In response to this request, General Smuts, when he became Prime Minister in 1919, persuaded Dr H J van der Bijl, a South African with a reputation for research in the new field of electronic engineering, to abandon a brilliant career in the United States to take up the post of head of the division and also to become the Scientific and Technical Adviser to the Government.

This move was prompted by a growing awareness internationally of the importance of science and technology. The demands made on manufacturing industries during the First World War in Britain, Germany, the USA and France accelerated developments which had been initiated in those countries towards the end of the 19th century. In a sense, these developments reflected science catching up with the Industrial Revolution. The British established an Advisory Council on Scientific and Industrial Research and in 1916 a separate Department of Scientific and Industrial Research (DSIR), responsible to the Advisory Council, was set up. This arrangement provided the model for what came to be known as the 'research council system' and was followed in Britain by the establishment of a Medical Research Council (MRC) in 1920 and an Agricultural Research Council (ARC) in 1931.

Australia, Canada, New Zealand and India followed Britain in setting up organizations for scientific and industrial research on the model of the DSIR. South Africa was the exception. This was not the fault of Dr van der Bijl. In a comprehensive report to the Government in March 1921, he had recommended the establishment of a government research institute to undertake research on problems of national importance, to investigate practical problems of individual firms and to carry out the testing of materials and the calibration of instruments.

On the question of government support for industrial research, he argued that research for industry was actively aided by the governments of the USA, UK and Germany, and that in South Africa there was even greater need for such assistance. He pointed out that for success in industrial research, large-scale specialized facilities manned by expert staff were required. As these could be afforded only by very large industrial corporations, there was a need for a central research institute to provide smaller firms with access to such facilities. He also stressed the importance of research in improving methods and processes of manufacture to combat competition in world markets.

Examples of areas in which he suggested that research in relation to industrial development should be undertaken included the economic uses of asbestos, the production of calcium carbide and its use as a feedstock for chemicals and synthetic motor fuel, the use of wood and clay deposits, and the country's fisheries resources. In other words, he visualized that industrial research and development should be resource related and recommended the establishment of a government-financed research institute for this purpose.

The van der Bijl proposals

Van der Bijl's proposals were held over by the Smuts Government pending a general election in 1924, and were not put into effect by the incoming Government under General Hertzog. However, van der Bijl devoted his energies to the development of the Electricity Supply Commission (ESCOM) of which he had been appointed chairman on its establishment in 1922, and later the South African Iron and Steel Industrial Corporation (ISCOR) and the Industrial Development Corporation (IDC). These three state corporations made a vital contribution to industrial development in South Africa.

Although his proposals for a government research organization to provide back-up for industrial research did not materialize, a Research Grant Board for the support of university research, set up in 1918 under the Department of Mines and Industries by the Advisory Board for Science and Industry, survived from the First World War initiatives. From a review of the work of this board by the chairman, Professor R B Young, it is apparent that during the period 1918–1935 it ably administered not only the limited government grants in aid of research and scholarships, but also generous gifts (£60 000 in all) by the Carnegie Corporation of New York for research in South Africa.

In 1938, the board was reconstituted into a new organization consisting of two bodies the – *National Research Council* and *National Research Board* under the Minister of Education, J H Hofmeyr. The National Research Council was essentially a policy advisory body of some 40 members appointed on a representative basis, while the Research Grant Board under the chairmanship of R B Young, consisted of eight members appointed on grounds of suitability. The board was an executive body which, in addition to administering research grants, was charged with the responsibility of translating into action the decisions and recommendations of the council.

Although this arrangement could be regarded as a step forward, the potential of the council and board was never fully realized because of the outbreak of the Second World War. The council did, however, recommend the establishment of a national research organization along the same lines as the research council system evolved in Britain and adopted by other Commonwealth countries.

Wartime impetus for science

South Africa's direct involvement in the Second World War gave a tremendous impetus to the manufacturing industry in this country and brought with it an increased awareness of the need for organized research in support of technological development. Van der Bijl, as Director-General of War Supplies, pressed all the engineering and industrial resources of the country into service. Co-ordinating her efforts with those of India, Australia and New Zealand, South Africa became an important workshop for the Middle East theatre of war, manufacturing millions of spares of many types and effecting repairs to aircraft and ships. She turned with success to the production of guns, bombs, armoured cars, precision instruments, military explosives and ammunition, and, in addition, supplied much in the way of clothing, blankets, boots and canned foods to the Allied forces.

Internationally, the war brought about a significant change in attitudes towards science. Spectacular successes were achieved in operations research 'in which teams of scientists from many different disciplines were drawn together to find solutions to specific problems in actual military operations. One outstanding example which justifiably captured the public imagination, was the development of radar – not merely as a technical device which would work in the laboratory but as an operational tool which would work in combat conditions'*.

However, the development of atomic bombs and their use against the Japanese were undoubtedly of the greatest significance. They have been described as one of the landmarks of history. The world could never be the same again. As Professor Margaret Gowing** has pointed out, it was one of the most fateful coincidences of history that the discovery of nuclear fission came in the same year as the outbreak of the Second World War.

*The atomic bomb –
little science becomes
big science*

Some of the profound changes brought about by the successful development of the atomic bomb in the short span of five years, largely because of the overriding imperative to 'get there first' (to which Gowing has referred), were the following:

- Little science had become big science. The alliance of 'pure' theoretical and experimental scientists with applied scientists and engineers and technological administrators had, within five years, transformed a tentative improbable idea into a vast project costing two thousand million dollars which produced two bombs which killed over a quarter of a million people and fearfully injured many more.
- The outcome of wartime research raised expectations that any practical technological objective that was also scientifically possible could be attained if sufficient resources and effort were devoted to it. This view gained credibility from the achievements of the chemical industry, which, impelled by wartime imperatives, developed and produced synthetic fibres such as nylon, antibiotics such as penicillin and pesticides such as BHC and DDT.
- Science had become indissolubly involved in the life and death of nations. Scientists – in particular physicists – became deeply implicated in national and international politics.

South Africa at this stage was undergoing a process of development which was unprecedented in its history. The sudden change from an agricultural and mining economy to one of a more diversified industrial nature, inevitably produced a variety of technological problems. These were compounded by the fact that, whereas South Africa was on the verge of an industrial revolution, the industrialized countries of the Northern Hemisphere were already moving into a period of new technology under the impact of 'big science'.

*Gummet, P. *Scientists in Whitehall*. Manchester, Manchester University Press, 1980.

**Gowing, M and Arnold, L. *The atomic bomb*. London, Butterworths, 1979.



Dr Basil Schonland
Appointed Scientific Adviser to the
Prime Minister in January 1945,
and in October, first President
(Chairman and Chief Executive
Officer) of the CSIR

The new era of science and technology

The Prime Minister of the day, General J C Smuts, a distinguished philosopher and scientist, a Fellow of the Royal Society of London and a member of the British wartime Cabinet, was acutely aware of the need for science in South Africa to be geared to meet the challenges of a rapidly changing world.

1945–1950

THE SCHONLAND ERA: A flying start

To this end he recalled Dr B F J Schonland from the European theatre of war and appointed him as Scientific Adviser to the Prime Minister, a post he took up in January 1945.

As professor of geophysics and director of the Bernard Price Institute of Geophysical Research at the University of the Witwatersrand, Schonland had established an international reputation for his research on lightning. At the outbreak of the Second World War in 1939 he organized the Special Signals Service which was responsible for the development and application of radar by the South African forces. He was then seconded to the British armed services with the rank of brigadier and became superintendent of the British Army Operational Research Group and later scientific adviser to Field Marshall Montgomery with the 21st Army Group during the invasion of Europe in 1944.

To this brilliant scientist Smuts assigned the task of formulating plans for the establishment of an organization 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. Schonland set to work immediately and as early as May 1945 his proposals, which provided for the establishment of a national research organization to be named the Council for Scientific and Industrial Research, were embodied in a Bill which was submitted to Parliament by the acting Prime Minister, J H Hofmeyr, and passed in June.*

Drafting the Bill

The drafting of the Bill was preceded by high-level consultation with government departments, universities, organized industry and scientific and technical societies. It is evident that Schonland also consulted leading overseas scientists, to whom he had ready access by virtue of his professional standing and wartime associations, about satisfactory forms of national research organizations. In submitting his draft Bill to the Acting Prime Minister, he indicated that in his view the most suitable models were to be found in Canada and Australia, both of which had national research bodies with corporate powers similar to those proposed in the Bill. His

* The Council for Scientific and Industrial Research was formally established on 5 October 1945 as a body corporate in terms of the Scientific Research Council Act (No. 33 of 1945) of the Parliament of the Union of South Africa (i.e. it became what is now generally referred to as a statutory body). Proclamation No. 204 signed on 22 September 1945 by M. J. de Wet, Officer Administering the Government, published in the Government Gazette No. 3553 of 5 October 1945.

proposals were based on the experience of these and other countries, and South Africa was thus able to profit by their experience and even by their mistakes.

According to Dr Schonland the purpose of the Bill was to promote the following:

- The better application of scientific research, pure and applied, to the development of the natural resources and industries of the Union.
- The proper co-ordination of research everywhere in the country in government departments, universities, technical colleges and all state-aided organizations.
- The training of the workers, including technicians, needed for scientific research.

He emphasized that these proposals were the culmination of earlier initiatives by the Government to create special machinery similar to that already in existence in other countries and also incorporated the recommendations of the former National Research Council and Board.*

Referring to the specific provisions of the Bill, Schonland proposed that the CSIR should be 'a body corporate', outside the Public Service, to give it the flexibility and the freedom which is essential for the atmosphere of scientific research. It should, however, be responsible to Parliament, through the Prime Minister, for its programme and its estimates, and its accounts should be audited by the Controller and Auditor-General.

In clarifying the scope of the proposed organization, he pointed out that, though not specifically stated in the Bill, the term scientific research would not include educational and social research for which the Government had other plans. Organizations responsible for agricultural research already existed and this field would therefore also be excluded.

In introducing the Second Reading of the Bill on 16 May 1945, Hofmeyr said: 'I am introducing this Bill not in my relatively permanent capacity as Minister of Education but rather in my transient capacity as Acting Prime Minister. The new organization which this Bill is intended to set up will take over most of the research activity of the Union Education Department and will be a co-ordinating organization within the scope of the Department of the Prime Minister.' He emphasized that 'national provision for the stimulation of research is essential, both from the point of view of national progress and from the point of view of national honour. A nation which neglects research is at the same time impairing its prospects of material welfare and weakening its status and dignity among the civilized nations of the world. Our prestige in relation to the size of our community stands high in the world outside and there is no reason to decry our scientific achievements. We have, however, fallen short in one respect in comparison with other countries, and that is in the general organization of our research activities and their co-ordination . . . We have certainly not realized to the full the very unique opportunities that South Africa offers

*CSIR –
'a body corporate'*

*Co-ordination and
stimulation of research*

* The National Research Council and Board were superseded by the CSIR (see p. 6).

as one of the most fruitful countries in the world for scientific investigation.'

Hofmeyr said the Government hoped to be able to secure the services of Schonland as president of the CSIR, and emphasized that the president would be both chairman of its council and its full-time chief executive officer. He 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.'

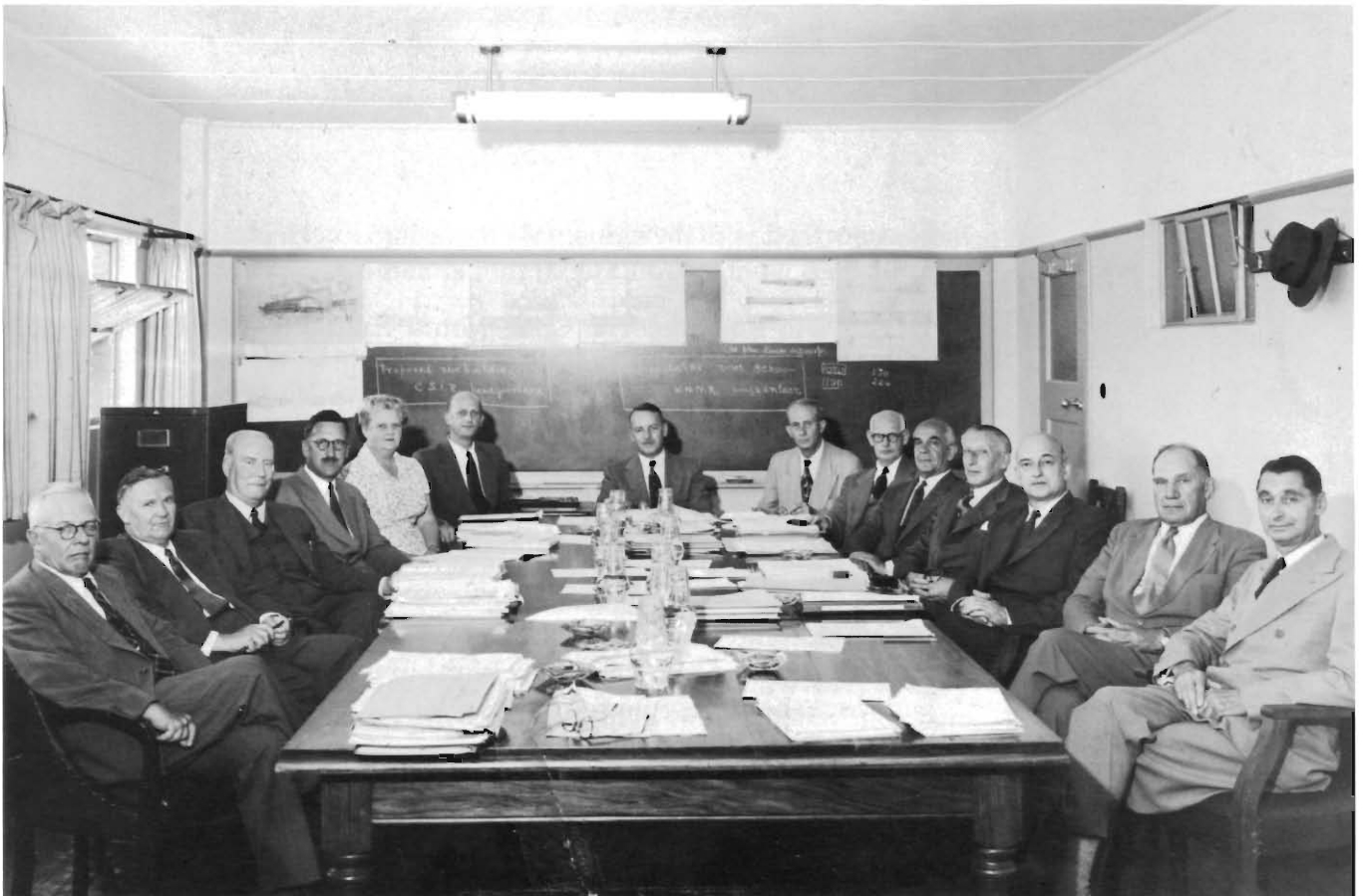
Enthusiastic support for CSIR Bill

The Bill was passed with enthusiastic support from both sides of the House. In the words of one of the leading speakers for the Opposition (Dr A J Stals, who was later to become Minister of Health) it was '. . . difficult to imagine any Bill being introduced into this House which would leave so little latitude for party differences.'

There was, however, some debate on the proposal to establish the CSIR as a separate body outside the government departmental structure, but the House accepted Hofmeyr's explanation that research required a different kind of organization, one with flexibility and the ability to respond quickly to the demands of changing circumstances. Other matters on which members asked for clarification concerned patent rights, medical research and relations with the South African Bureau of Standards (a Bill for the establishment of which had been passed earlier in the same session of Parliament). Hofmeyr said the CSIR would be expected to explore and develop medical research, but that this was a field which would eventually justify a separate controlling body. His replies on the question of standards were less convincing and the doubts expressed by members of Parliament proved to be well-founded.

The steps to be taken towards setting up the CSIR were outlined in Dr Schonland's notes on an interview with General Smuts on 20 July 1945. The practical details concerned with the setting up of the CSIR were to be dealt with by a Cabinet committee known as the Reconstruction Committee, consisting of the Prime Minister and the Ministers of Education and of Economic Development. The Prime Minister had agreed to consider adding the Ministers of Agriculture and Mines to this committee. He had also agreed to the appointment of the following as members of the first Council of the new organization:

Dr B F J Schonland (President, Chairman and Chief Executive Officer), Dr F J de Villiers (Industrial Adviser, Department of Commerce and Industry), Dr P J du Toit (Director, Division of Veterinary Services, Department of Agriculture), Dr S H Haughton (Director, Geological Survey), Dr Bernard Price (Chairman, Victoria Falls and Transvaal Power Company), Dr J Smeath Thomas (Master, Rhodes University College), Mr T P Stratten (Consulting Engineer, Union Corporation), Dr H J van Eck (Chairman, Industrial Development Corporation), Dr R W Wilcocks (Rector, University of Stellenbosch), Mr J E Worsdale (Chairman, Cape Portland Cement).



CSIR COUNCIL MEETING, PRETORIA, FEBRUARY 1954

Sitting left to right: Dr R W Wilcocks, Mr F J du Toit, Dr T B Davie, Mr P E Rousseau, Mrs P N Botha (Minutes Clerk), Mr J R Sorrie (Secretary/Treasurer), Dr S M Naudé (President), Mr E W Dohse (Vice-President), Dr E Taberner, Dr P J du Toit (Adviser), Dr B F J Schonland, Dr H J van Eck, Prof E T Stegmann, Dr F J de Villiers

All of them were eminently qualified to meet the requirements of the Act which stated that the Council members should be 'persons who have distinguished themselves in science or industry, or who are otherwise specially qualified in relation to some aspect of the work of the Council.' Except for the president the period of appointment was for three years, but for those first appointed the periods would be staggered. Schonland proposed to the Prime Minister that his own period of appointment should initially be until 1947.

On more specific issues, Smuts indicated that the CSIR should be located in Pretoria and that interim accommodation could be rented from the Public Works Department in premises adjacent to the Mint in Visagie Street which had been occupied by the Munitions Section of the Mint during the war. He agreed that the services of two or three suitably qualified ex-servicemen awaiting demobilization could be secured to take over the scientific mission work in London and Washington even before formal constitution of the CSIR.

Before the CSIR's formal establishment, Smuts called a meeting of the heads of government departments, with Schonland as chairman, to discuss and review the relationship of the CSIR with the following departments:

- **Agriculture and forestry.** The CSIR would not be concerned with research related to the living plant or animal except in support of research in the basic biological sciences at universities and museums, but would

be concerned with the industrial processing of agricultural products such as leather, wool, cotton, sugar, timber and forest products.

- **Health and housing.** The CSIR would handle all investigations and research connected with building methods and materials in collaboration with the National Housing Commission and the Director of Housing. This work would be undertaken by a building research institute in which a housing research unit which had operated under the Department of Commerce and Industry during the war would be incorporated. The CSIR would also co-ordinate and develop laboratory research on nutrition and related health matters.
- **Commerce and industry.** The CSIR would be responsible for research and investigation into standardization but not undertake routine testing, and would be represented on the Standards Council by the president (and *vice versa*).

The scientific missions abroad and related scientific and technical information bureaus would be taken over from the Department of Commerce and Industry and extended by the CSIR.

- **Semi-government bodies:** Formal relationships with the Fuel Research Institute, Government Metallurgical Laboratory and the South African Institute for Medical Research would be subject to negotiation.

Council's first discussions

Schonland called an informal meeting of the Council on 27 August 1945 to brief its members and get their views on questions of principle and policy. There was, for example, the need to avoid the dangerous security of the Public Service which, with its low rate of pay and promotion by seniority, was seen as not conducive to creative research. He explained that this had to some extent been avoided by the Government's decision that the CSIR should be outside the government service while, at the same time, a measure of security was provided by the inclusion of its staff in the Provident Fund for University Staffs.

Another issue was the involvement of the State in applied industrial research. Members of the Council insisted that industries should be encouraged to accept responsibility for the funding of technological research, with appropriate assistance and incentive provided by the Government. The CSIR, on the other hand, should concern itself with basic research which would inevitably be neglected by industry. Thus the proposal for the establishment of a National Building Research Institute and a National Industrial Chemical Laboratory was questioned.

A vexed question concerned standardization and relations with the Bureau of Standards. What emerged from the discussion was that the CSIR would be responsible for the determination of fundamental standards of physical quantities or units as well as research in this context, whereas the SABS would primarily be concerned with quality acceptance standards for manufactured products and the relevant testing services; a safeguard for observance of these principles in practice would be that the president of the

CSIR would be a member of the Standards Council and the chairman of that council (Dr F J de Villiers) a member of the CSIR Council.

The first formal meeting of the Council after the CSIR was legally constituted on 5 October 1945 was held at the Union Buildings in Pretoria on October 8 and 9. In an address to the members, the Prime Minister said: 'I am confident that this body will become one of the most important organizations of advancement in this country. 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 those 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.'

At that meeting the Council discussed a basic policy statement prepared by Schonland. After it had been edited in the light of comments by members of the Council, it was published in December 1945 and tabled in both Houses of Parliament.* It was well received and was to remain the basic policy guideline for the CSIR for many years to come.

This statement outlined the plans of the Council for:

- Encouragement of research by individual firms through *remission of income tax*.
- Development of *co-operative industrial research institutes* supported by associations of firms.
- *Establishment of national scientific laboratories* – a National Physical Laboratory, a National Chemical Research Laboratory and a National Building Research Institute to undertake long-term research and short-term *ad hoc* investigations on behalf of industrial firms on a contract basis.
- *Fostering research in universities* through grants and bursaries, and in co-operation with universities, creating conditions in which the best science students could be offered a reasonable livelihood in scientific research.
- *The establishment of a central library and technical information service* as well as *scientific missions* in London, Washington and other centres to provide a well-organized flow of information from the best sources in the world.

Although not specifically mentioned in *Objects and Policy of the CSIR* (see above), the Council agreed to proposals by Schonland for the establishment of a Telecommunications Research Laboratory outside the framework of the National Physical Laboratory and a Bureau of Research in Industrial Psychology. Both were regarded as 'special projects' intended to ensure the continuity of specialized wartime activities.

At the second meeting of the Council, held on 11 and 12 February 1946, the president reported on a meeting of the Cabinet Committee on Reconstruction he had attended on 19 November 1945. The members were



General J C Smuts, Prime Minister of the Union of South Africa, addressing the first formal meeting of the CSIR Council on 8 October 1945

* *The Objects and Policy of the South African Council for Scientific and Industrial Research – An initial Statement*. Council for Scientific and Industrial Research, Pretoria, 1945.

Mr J H Hofmeyr and Mr S F Waterson with General Smuts as chairman. The meeting had approved the following:

- A statement on the objects and policy of the CSIR (see above).
- Estimates of expenditure, subject to confirmation by the Minister of Finance.
- CSIR salary scales proposed by the Council; an assurance was given that the Public Service Commission was satisfied that these scales 'would not give rise to difficulties in the Public Service'.
- Procedures for research grants to universities.
- The appointment of a Council subcommittee to investigate future relations with the Fuel Research Institute.
- The Committee on Reconstruction also authorized the CSIR to nominate representatives to sit on the governing body of all government-aided research bodies or associations outside the Public Service.

Schonland leaves: the CSIR well and truly launched

In 1950 Schonland decided to relinquish the post of president of the CSIR and to return as full-time director of the Bernard Price Institute of Geophysical Research, a position he had retained part-time during the war and while he was president of the CSIR. He remained a member of the Council until he left South Africa in 1954 to take up the post of deputy director of the Atomic Energy Research Establishment in Harwell, England. He was eventually to receive a knighthood to become Sir Basil Schonland.

At this juncture it is appropriate to take stock of what Schonland had achieved first as scientific adviser to the Prime Minister, during which time he was concerned with drafting the Scientific Research Council Bill and with follow-up action preliminary to the legal constitution of the CSIR, and then as president of the CSIR for five years.

Secretarial, financial and administrative services had been built up, and scientific and technical information services had been provided by the CSIR's Central Library and Information Division and by a Liaison Division in association with the CSIR's scientific liaison offices in London and Washington.

By 1950 the scheme for university research grants, which had been introduced by the CSIR in 1946, was working smoothly and helping to stimulate the postgraduate training of research workers who were urgently needed by the Government, by industry and by the universities and other research organizations. The CSIR's financial provision for university research (excluding medical and dental research) had increased from £1 476 to about £50 000 a year.

The introduction of a scheme for medical and dental research units at universities and other research organizations had provided effective procedures for financial support of continuing research under leading medical research workers, guided by a Medical and Dental Research Committee.

Four industrial research institutes had been established under an industrial research association scheme introduced by the CSIR. They were the Leather Industries Research Institute, the Fishing Industry Research Institute, the

Paint Industries Research Institute and the Sugar Milling Research Institute. All of them were nearing the end of the first five-year period for which the contributions of industrial subscribers were guaranteed.

By 1948 five national research institutes had been established. They were the National Physical Laboratory (1946), National Chemical Research Laboratory (1947) and National Building Research Institute (1946) (all in Pretoria) and, in Johannesburg, the Telecommunications Research Laboratory (1946) and the National Institute for Personnel Research (1948)*. According to Schonland, these national institutes provided staff of high quality and specialized equipment of the most modern type for the country's research needs. The scope of these institutes, even at that early stage, was impressive. According to a brochure, *National Research Laboratories and Services*, published by the CSIR in 1950 –

- The National Physical Laboratory had divisions for electrical standards of reference, electronics, acoustics, applied geophysics, physics of matter, nuclear physics, biophysics, heat, optics, mass spectrometry, spectroscopy and spectrochemical analysis, X-ray diffraction and electron microscopy.
- The Telecommunications Research Laboratory was engaged in measurement of ionospheric characteristics and absorption, ground-wave propagation and radio noise, monthly predictions of high-frequency radio propagation conditions, maintenance of a primary standard of radio frequency, the study of radio noise and its effects on radar and radar systems, and applications of radio and radar to special problems.
- The National Chemical Research Laboratory had a division active in the field of physical and analytical chemistry, for example gas adsorption measurements, metallic corrosion, clays and related materials and electrochemistry. (Another division in the field of organic chemistry was engaged in research programmes on the chemistry of available raw materials aimed at facilitating their industrial use, for example plant and animal products, coal, tars and bituminous materials. It also had divisions for process development, with facilities for small-scale pilot plant development, for microbiological chemistry and for water treatment).
- The National Building Research Institute had specialized divisions for engineering, soil mechanics, functional efficiency, architecture and materials of construction, and participated in multidisciplinary programmes involving national problems such as low-cost, high-density urban housing.
- The activities of the National Institute for Personnel Research were organized in divisions oriented towards the requirements of the main fields of application. (Research for the Defence Force and Public Service departments was concerned with screening and classification tests; aptitude tests for artisan trainees and air crews; selection procedures for higher grade administrative personnel, officer cadets, scientific assistants and research workers; merit ratings and other methods of proficiency assess-

* As a point of interest, the designation 'laboratory' was retained for physical and chemical research, while all other research was organized in 'institutes', 'units' and 'groups'.

ment; causes of maladjustment to service conditions and remedial measures. The other major division was engaged in research for industry, commerce and the mines, and included screening and classification tests, training procedures and techniques, efficiency in the work situation and industrial relations. These two main divisions were backed by basic research in such fields as test construction and statistics).

Schonland was able to record that . . . even at this early stage we are fully satisfied on two important points. The first is that there is a great need for these national laboratories; we cannot keep up with the demands made on them by industry and there is every indication that we shall need more staff and more specialized equipment than we have at present.' He added that 'South Africa can produce research workers of a quality and keenness second to none in the world. We find it desirable to send a good many of our men overseas for a year or so to work in larger laboratories there, to get acquainted with the latest techniques and ideas, and particularly to get in touch with overseas thought and standards of work. But we now have no doubts as to their quality.'*

The extent of the demand for the services of these research institutes was reflected in the following statement in the CSIR's 5th Annual Report (1950): 'The total cost of 158 applied research projects and investigations undertaken for industrial and other sponsors this year amounted to £65 067 11s 8d. Of these 133 were new projects while 25 were carried over from the previous year.'

According to Schonland, these activities reflected the enthusiasm and initiative of the entire staff and particularly of the directors of the laboratories, the secretary/treasurer and administrative staff, and of the officers responsible for services such as library and information, workshops, industrial liaison and scientific liaison overseas.

There were, however, some matters which remained to be resolved. For example, the CSIR's involvement with the Fuel Research Institute and the Government Metallurgical Research Laboratory was limited to representation on the boards of these bodies. This effectively excluded the CSIR from research on mineral resources except those of a fundamental and peripheral nature.

CSIR and SABS

With regard to relations between the CSIR and the South African Bureau of Standards, Schonland said 'The lines of demarcation between routine testing, specialized testing, investigations and research can never be clearly drawn. A working arrangement has, however, been come to between the CSIR and the Standards Bureau, whereby serious overlapping in investigational test work is avoided by a monthly meeting of the Director of the Standards Bureau and myself, together with the heads of the CSIR laboratories. This arrangement is satisfactory at present, but it is dependent upon goodwill and mutual agreement and as the two bodies grow it will at times be difficult to get agreement on fields of work. I have always held the view that the laboratories, workshops and libraries of the Standards Bureau

* *Journal of the South African Institution of Engineers*, September 1948, p. 26.

should be administered by the CSIR and the Standards Act was modified at my request to make this possible at any time. I believe that this change will be necessary as the expenditure of the two bodies increase.*

In 1948 an Act establishing an Atomic Energy Control Board was passed by Parliament. In reporting to his Council on the relationships of the CSIR with this body, Schonland explained that:

- The CSIR nominates a member and an alternate to serve on the board.
- The CSIR becomes responsible as an agency of the board for all imports of radio-isotopes and their proper use and for advice on research in fissionable materials.
- The board is empowered to make financial grants in aid of research or to do research itself 'in connection with the extraction, recovery, refinement or purification of fissionable materials', but only 'in consultation with the Council for Scientific and Industrial Research'. By implication, therefore, research on atomic piles and such matters was the province of the CSIR.

These were some of the issues which Schonland left to his successors to resolve. However, the foundations for the future development of the CSIR had been laid. After five strenuous and stimulating years, the CSIR was operating effectively as a vital and vigorous organization.

Furthermore, the CSIR had been extremely fortunate in receiving, as a gift from the University of Pretoria, 100 hectares on the university experimental farm east of Pretoria, and plans were well advanced towards providing a permanent home for its headquarters and national institutes on this magnificent site.

In addition to the tremendous asset which Schonland had created in the CSIR, a framework had been provided for scientific and technical co-operation in Africa through the Scientific Council for Africa South of the Sahara. This Council was set up in 1950 following the successful African Regional Scientific Conference in Johannesburg in October 1949 and organized by the CSIR and the Department of Foreign Affairs.

1950–1952

THE DU TOIT INTERLUDE: A period of consolidation

When Schonland relinquished the position of president of the CSIR to return to his former post at the University of the Witwatersrand, he was succeeded on 5 October 1950 by Dr P J du Toit. Du Toit had served under Schonland as deputy president after retiring in 1948 as director of the Veterinary Research Institute at Onderstepoort, a post he had held since 1927. Dr S Meiring Naudé, who had been director of the CSIR's National Physical Laboratory since 1946, was appointed to the new position of vice-president (which did

*Gift of a permanent
home site*



Dr P J du Toit
President 1950–1952

* Report to Council on submission to a Government Committee investigating CSIR relationships with bodies such as the FRI, GML, SABS and the National Roads Board.

*Scientific co-operation
in Africa*

not include membership of the CSIR Council). It was generally accepted that he was being groomed for eventual appointment as president.

After the hectic growth of the first five years, it was inevitable that there should be a period of relative calm – a period for consolidation and reflection. This came about during du Toit's office, but the CSIR did not become stagnant. Du Toit was heavily involved in his personal commitments as chairman of the Scientific Council for Africa South of the Sahara and the all-important issues of regional scientific co-operation in Africa.

On the 'home front' the CSIR pressed ahead with its building programme, priority being given to small special-purpose buildings for acoustic research, a cyclotron and a windtunnel. The first major laboratory building, which was to house the National Building Research Institute, was scheduled for completion in 1953.

On the industrial front the first steps were taken by a CSIR action committee with Dr du Toit as chairman to set up the South African Wool Textile Research Institute pending its registration as an autonomous, non-profit company under the CSIR's industrial research association scheme. The initiative for this development came from the Wool Board with support from the South African textile industry and later from the Mohair Board. A development of long-term significance for road research in South Africa was the formation of the CSIR's Bituminous Binder Research Unit in 1951 as a joint venture with the Department of Transport, the Provincial road authorities and the local producers of 'black-top' road surfacing materials.

A change with far-reaching implications which occurred during this period was that responsibility for the CSIR was transferred from the Prime Minister, Dr D F Malan, to the Minister for Economic Affairs, E H Louw, who was also the minister responsible for the S A Bureau of Standards. This move inevitably diminished the status of the CSIR as a co-ordinating and advisory body to the Government on all matters affecting scientific and industrial research.

Dr du Toit, whose one-year appointment as president was extended for another year, retired in October 1952. He relinquished membership of the council but retained his association with the CSIR by accepting an appointment as adviser to the President on biological research. He also continued to be Chairman of the Scientific Council for Africa South of the Sahara.



Dr S M Naudé
President 1952–1971

1952–1971

THE NAUDÉ PERIOD: Vigorous growth and development

Dr du Toit was succeeded, as expected, by Dr S Meiring Naudé. The indications are that when Schonland was setting up the CSIR in 1945, he had his eye on Naudé as a possible successor, and had invited him to become the first Director of the National Physical Laboratory, a post he took up in January 1946. With characteristic drive and energy, he set about this assignment and by 1950 the NPL was a going concern. He strongly favoured the appointment of outstanding young graduates from South African

universities and sending them to selected overseas institutions for further training. This policy was brilliantly vindicated and in later years Naudé's 'kindergarten' made outstanding contributions to the development of physics in particular and to science generally in South Africa.

But perhaps his most significant contribution to the development of the CSIR during his five years as director of the NPL was through the role he played in securing from the University of Pretoria the site on which the CSIR's buildings were to be erected. As vice-president, Naudé was able to give detailed attention to the lay-out and development of the site, including the provision of basic services such as an electricity distribution station, sewerage and other amenities.

Naudé was succeeded as vice-president by Mr E W Dohse, chief engineer of the Department of Public Works. In 1945, Dohse was attached to the Department of Commerce and Industry as building research adviser and was assigned to assist Schonland in setting up a National Building Research Institute within the proposed CSIR. In this capacity he visited various research organizations in Britain and the United States and, when the CSIR was formally established, served as acting director until a permanent director, Mr J E Jennings, was appointed in May 1947. Dohse became the chairman of the Building Research Advisory Committee in 1945, an office which he held for 18 years. His appointment as vice-president of the CSIR in 1952, at a time when the CSIR was engaged in a major building programme, was singularly appropriate.

Naudé as president and Dohse as vice-president set up what came to be known later as the CSIR Executive. It was supported on the one hand by the secretary/treasurer, Mr J R Sorrie, and his successors, who provided the secretarial services for the council and the administrative services for the research organization such as accounting and staff administration, as well as building services, which later became concentrated in an Estates Department. On the other hand, professional services were provided by the Liaison Division under Mr DG Kingwill. These concerned industrial liaison, setting up of co-operative industrial research institutes, units and fellowship programmes, establishment of regional research liaison committees, and patenting and development of inventions. Other services involved technical information for industry, public information, international relations and the CSIR's overseas offices, university research grants and support for medical research. Common services were provided by the Library and Information Division under Miss Hazel Mews, and the Central Workshops under Mr O Garnett and later under Mr J van der Staaij.

In the years following the appointment of Dr Naudé as president, this team was to be subjected to increasing pressures resulting mainly from the First World/Third World situation in which South Africa found itself in the post Second World War period which was characterized by an unprecedented expansion of research and development. This new era of so-called 'big science', which expanded rapidly during the 1950s, was marked by a demand for bigger and better particle accelerators, the advent of radio astronomy, the development of supersonic jet aircraft, and the conquest of space. Oddly enough, it was the preoccupation with space research, with its



Mr E W Dohse
Vice-President 1952–1957

stringent demands for 'fail-safe' communications and data control, that was to provide the stimulus and incentive for developments in information technology which were to bring civilization to a watershed situation comparable to that created by the invention of the wheel and of printing.

The problems posed by this explosion of research and technology were complicated in South Africa by factors such as the shortage of trained scientists and engineers, the relatively underdeveloped state of research at the universities, the virtual absence of technologically oriented training and research institutions at the level of tertiary education, the lure of the 'fashionable' fields of research, and the burgeoning of research in Western Europe and North America, which tended to attract the most gifted young South African research workers – in other words, the so-called brain drain. In this situation the CSIR was faced with two conflicting requirements. On the one hand, it was more or less obliged to develop research for South Africa's rapidly developing industry in such a way as to generate centres of excellence to serve as windows on developments elsewhere at the 'cutting edge' of scientific research and high technology. On the other hand, it was faced with the challenges posed by the need to apply science and technology to solving the problems of development in the rural areas where a large proportion of the population was still living at the fairly primitive level of a subsistence economy. This was a field in which leading scientists, not only in South Africa but also in the rest of the world, had and still have much to learn.

*Emphasis on
excellence*

In this period of rapid technological change and expansion of organized research and development, it was inevitable that the hand at the helm of the CSIR in a country such as South Africa, with its dualistic economy, would be confronted with multiple choices in deciding on the most appropriate course to follow.

It is to the credit of Dr Naudé that, in this complex situation, he adopted a flexible attitude, what in management jargon has been described as a 'bottom up' approach, responding to initiatives from below, allowing limited encouragement for new directions of research for which there was financial support from industry or other sectors – but always insisting on scientific excellence, especially in the appointment of staff, and particularly of senior staff. He was fiercely protective of this principle and resisted all pressures from outside which threatened it, such as those which might be expected from the dictates of national policy. Thus the CSIR grew and developed in accordance with the levels of sponsorship for research which, at a later stage, was identified by Lord Rothschild in Britain as the 'customer contractor' principle. It was inevitable with this *laissez faire* approach to the direction of research (as opposed to administrative management), that some mistakes would be made, but the quality and integrity of CSIR research were never in question. The main requirement, to establish a basic research and development capability related to the country's needs, was met.

From time to time stresses and strains developed, often attributable to competing calls for research funds from different groups such as the academics in the universities and research staff in the Public Service. In 1957, for example, the Treasury placed a seven per cent limit on the annual growth

of the CSIR's budget and, to an increasing extent, limits were imposed on the discretion of the CSIR in determining appropriate salary scales for its staff.

As the CSIR's national research institutes developed, they came into competition with other research agencies. This tended to compromise the national advisory and co-ordinating role of the CSIR, and the establishment of a Scientific Advisory Council in 1962, with a part-time chairman (Dr H O Mönnig, who was also scientific adviser to the Prime Minister) was welcomed in that it created a neutral forum for the discussion of policy issues affecting research and development with other R & D organizations.

Under Dr Naudé's presidency the staff increased from 685 to over 4 000 and the number of national institutes of the CSIR grew from five to 13, most of them developing out of the National Physical Laboratory and the National Chemical Research Laboratory in response to the demand for their services in fields of research as diverse as nutrition and food technology, water treatment, road construction, mechanical engineering, electrical engineering, mathematical sciences, defence research, and scientific and technical information.

In 1953 the government Department of Nutrition provided funds and staff to set up a nutrition research group within the National Chemical Research Laboratory. The next year this became a separate National Nutrition Research Institute under Dr A W Lategan, formerly technical adviser to Federale Nywerhede Bpk. When in 1957 Dr Lategan became director of the South African Bureau of Standards he was succeeded by Dr F W Quass.

In 1954 Dr F J Hewitt, who had been head of the Telecommunications Research Laboratory of the CSIR since its inception in 1945, was promoted to director of the National Institute for Telecommunications Research as it was renamed. The following year Dr N Stutterheim, who had been head of the Materials Division of the National Building Research Institute since its establishment in 1946, became director of the NBRI when Mr J E Jennings left to become head of the Department of Civil Engineering at the University of the Witwatersrand. In the same year, the Mechanical Engineering Research Unit which had been set up in 1952 under the wing of the National Physical Laboratory, became the National Mechanical Engineering Research Institute and Dr A J A Roux relinquished his post as director of the NPL to become its full-time director. Dr Roux had joined the CSIR in 1946 as head of the Functional Efficiency Division of the National Building Research Institute and in 1951 had been appointed director of the NPL* and head of the Mechanical Engineering Research Unit. He was succeeded as director of the NPL by Dr E J Marais.** In 1955, negotiations on a proposal to create a National Institute for Road Research were brought to finality and the formation of this Institute was formally announced in September. Its running expenses were guaranteed by the National Transport Commission and the provincial administrations through the Department of Transport on

*A neutral forum to
review science policy*



Dr A J A Roux
Vice-President 1957-1959

* On Dr Naudé's appointment as vice-president, Dr O Brune, head of the Electrical Standards Division, was made acting director of the NPL until the appointment of Dr A J A Roux as director.

** National Physical Laboratory (NPL) renamed National Physical Research Laboratory (NPRL) in 1956.

the understanding that the CSIR would be responsible for buildings and capital equipment. This provided an excellent example of the 'customer contractor' principle. Dr P J Rigden, who had been director of the Bituminous Binder Research Unit since 1950, was appointed director of the new institute, into which the unit was incorporated.

The South African Wool Textile Research Institute (SAWTRI), which had been set up in 1951 at Rhodes University, Grahamstown, was registered as a non-profit company in 1954 and formally opened in 1955. In that year the first director, Dr R C Palmer, left and was succeeded by Dr C C Kritzing.

By 1955, 10 years after the establishment of the CSIR, some 510 research papers from its own laboratories and research institutes had been accepted for publication, 380 from holders of CSIR research bursaries, and 250 from CSIR medical research units. In addition, several monographs and books had been published, either by the CSIR itself or on its behalf. This gives some idea of the scientific contributions of the staff which, at the end of the previous year, numbered over 700. Sixty-one of them held doctor's degrees and 158 MSc, BSc(Hons) or BSc(Eng) degrees; 150 held first degrees – most of them engaged in extramural studies for higher degrees with financial assistance from the CSIR.

Reference has been made to the establishment of the Atomic Energy Board in 1948 in terms of an Act of Parliament which Schonland had helped to draft. The immediate objective was to regulate the uranium industry but provision was made for supporting research and development 'after consultation with the CSIR' (as stated in the Act).

The CSIR, for its part, had established a nuclear physics and applied radioactivity group in the NPL which designed and developed a 16 MeV cyclotron. This became operative in 1955 and was formally commissioned in 1956. Progress had also been made in promoting and providing assistance in the application of radioactive isotopes in research and medical practice, and in providing related services including the importation of radioisotopes. A novel scheme for transporting radio-isotopes in the wingtips of aircraft, developed by the NPRL, gained international acceptance.

Peaceful uses of atomic energy

In 1955 a three-man mission consisting of Dr Meiring Naudé, Dr J T Hattingh, chairman of the Electricity Supply Commission (Escom), and Dr H J van Eck, chairman of the Industrial Development Corporation (IDC), was appointed to investigate the industrial uses of atomic energy in Europe. Together with Mr Osborne, Secretary of Mines, they represented South Africa at the First United Nations Conference on the Peaceful Uses of Atomic Energy. On the basis of the report of this mission, drawn up by Dr Naudé, the Government appointed a commission of enquiry into the application of nuclear power in South Africa which began work in February 1957. In the meantime, the Atomic Energy Board had in November 1956 constituted a Permanent Research Advisory Committee, and the following year the CSIR appointed Dr A J A Roux (director of the National Mechanical Engineering Research Institute) to the position of a vice-president of the CSIR with a specific responsibility for formulating an atomic energy research programme. Dr W L Grant became director of the NMERI and when in 1960 he left to take up an appointment with the Atomic Energy Board he

was succeeded by Dr H G Denkhaus. In 1959, Dr Roux decided to leave the CSIR and transfer to the Atomic Energy Board. In June of that year he presented his proposals for a nuclear research and development programme which envisaged a national nuclear research centre separate from the CSIR with a budget of £800 000 a year for the first five years. This proposal was not unanimously accepted by the board and for a time there was considerable controversy. Eventually, in September 1959, it was announced that his proposals had been approved by the Government. At one stroke this decision excised one of the CSIR's main thrusts in a most significant field of high technology and big science, and its effects on the CSIR's course of development, and indeed research and development in the country as a whole, can hardly be overestimated.

Mention has been made of the reservations expressed in 1945 by members of Parliament during the second reading debate on the Research Council Bill about the wisdom of setting up the Council for Scientific and Industrial Research and the South African Bureau of Standards (for which a Bill had been passed in the same session) as separate, autonomous bodies. When the then Opposition became the Government in 1948, there was some enquiry into this situation. In the belief that economies and other advantages would result if the two bodies were brought under the same management, the Government passed the Standards (Transfer of Administration) Act which became operative on 17 August 1956. In terms of this Act, the Council for Scientific and Industrial Research, enlarged by the addition of members selected for their special knowledge of standardization, assumed all the powers and functions formerly exercised by the Council of the South African Bureau of Standards, which was abolished as an independent body. These powers included, among others, control of the finances and testing laboratories of the SABS, the determination of policy in regard to the preparation of specifications and codes of practice, and the administration of the national hallmark and standardization mark schemes.

As the Bureau's work required frequent short-notice decisions, and as the CSIR Council did not meet frequently, it was decided to appoint a special committee along the lines of the CSIR's national research advisory committees to handle the affairs of the Bureau. A number of executive powers was delegated to this committee, named the Standards Council, which met every six weeks.

In the following year the Standards Council met eight times under the chairmanship of the president of the CSIR. Certain general and administrative services of the two bodies were centralized. These included staff administration, accounts, library, instrument workshops, publicity and public relations, translation, and statistical and photographic services. The national testing laboratories of the Bureau were to continue to operate as in the past. The director of the SABS since its inception, Mr James Ritchie, resigned and Dr A W Lategan, director of the National Nutrition Research Institute of the CSIR, was appointed to this position.

Unfortunately, some of the staff of the SABS were unhappy with this reorganization and Dr Lategan, finding himself in an invidious position, aligned himself with the staff of the SABS, which resulted in a confrontation

Amalgamation and separation of the CSIR and SABS



Dr W S Rapson
Vice-President 1958–1962

situation with the CSIR executive. To make matters worse, this attracted the attention of the media. After intensive discussions, the Government appointed Mr F G Barrie (Auditor-General) as a one-man commission to enquire into all aspects of the problem. The Government accepted a recommendation by Mr Barrie that the CSIR and the SABS should once again become separate statutory bodies and this was implemented in 1962 under the Scientific Research Council Act (Act No. 32 of 1962) and the Standards Act (Act No. 33 of 1962).

During the 1950s the CSIR became increasingly involved in complex questions relating to the patenting of inventions by its own staff as well as those arising from research supported by the CSIR at universities and research undertaken under contract to industrial firms. A patents section was therefore formed under Mr E Boden in the Liaison Division. By 1961, the CSIR had earned royalties to the value of R450 000, largely owing to the success of two inventions by Dr T L Wadley of the National Institute for Telecommunications Research – a principle of variable frequency crystal control of radio equipment and the Tellurometer system of distance measurement. At that stage it was decided to create a separate body for handling patents and inventions and the South African Inventions Development Corporation was established in 1962 as a statutory body. Mr A M Schady, who had taken over from Mr Boden as head of the Patents Division, was appointed manager.

In 1958 Dr W S Rapson, founder director of the National Chemical Research Laboratory, was appointed vice-president following the retirement of Mr E W Dohse, and Dr P C Carman became the new director. In the same year the status of the Water Treatment Division of the National Chemical Research Laboratory was elevated to that of National Institute for Water Research with Dr G J Stander, who had been head of the division since 1950, as director. Also in 1958 the Library and Information Division combined with the Liaison Division to form the Information and Special Services Department under the former head of the Liaison Division, Mr D G Kingwill, who was promoted to director of Information and Research Services in 1962. In a further reorganization, an Administrative Services Department (under the secretary/treasurer, Mr A J Miller Smit, who had succeeded Mr J R Sorrie in 1955) and an Estates Division (under Mr D J J Bisschoff), both separate from the Office of the President, were established. At the same time all services of a technical nature were combined to form a Technical Services Department under Mr J van der Staaij, who had been head of the Central Workshops since 1955. In 1963 Mr van der Staaij was promoted to the rank of director.



Dr N Stutterheim
Vice-President from 1959
Deputy President 1967–1969

In 1959 Dr N Stutterheim, director of the National Building Research Institute, was appointed a vice-president in place of Dr A J A Roux, and Dr T L Webb became the new director of the institute.

Another development which was linked with the CSIR's growing demand for additional computing services (and thus with data and information processing) was the establishment in 1961 of a separate National Research Institute for Mathematical Sciences, incorporating the Mathematics and Electrical Engineering Divisions of the National Physical Research Labora-

tory, with Dr A P Burger as director (previously head of the Mathematics Division of the National Physical Research Laboratory).

In 1962 the first steps were taken towards the development of a programme of defence research in close collaboration with the South African Defence Force. This programme was coordinated by a Defence Research Council with the Minister of Defence as chairman and the president of the CSIR as vice-chairman. Professor L J le Roux, formerly chief chemist of the Atomic Energy Board, was appointed executive officer of the new council and a vice-president of the CSIR. In 1963 Dr J P A Lochner, formerly head of the Acoustics Division of the National Physical Research Laboratory, was appointed director of a National Institute for Rocket Research and Development. In 1965 Professor le Roux resigned and the president, Dr Naudé, personally took charge of the defence research function at executive level. In the subsequent reorganization, Dr T J Hugo, head of the Optics and Spectroscopy Divisions of the National Physical Research Laboratory, was appointed director of the National Institute for Defence Research and Dr Lochner took up an appointment at the University of Port Elizabeth.

It should be mentioned that the National Institute for Personnel Research and the National Institute for Telecommunications Research had, since their inception in 1945, been involved in contract research for the Department of Defence – the former in staff selection and training, and the latter in developments in radar, radio communications equipment and position fixing, and distance measurement.

Significant changes occurred in 1962 in the senior staff establishment. Dr W S Rapson, a vice-president, left in February to take up an appointment as research adviser to the Transvaal and Orange Free State Chamber of Mines in Johannesburg. This post had, incidentally, been created as a result of the recommendations of Dr Schonland who had been commissioned by the Chamber to review the research needs of the mining industry in South Africa. In his place, Dr E J Marais, director of the National Physical Research Laboratory, was appointed a vice-president and was succeeded as director of the NPRL by Dr A Strasheim, head of the Spectrochemistry Division of that laboratory. Another of the founders, Dr Simon Biesheuvel, director of the National Institute for Personnel Research since its establishment in 1946, joined the South African Breweries as executive director responsible for the staff function. The impetus given to personnel research in South Africa was maintained by his successors, all of whom had served their tutelage under him. They were Dr D J Gouws (1962–65), Mr D J M Vorster (1965–77) and Dr G K Nelson (from 1977).

When Dr Marais left in 1964 to become the first rector of the new University of Port Elizabeth, Dr F J Hewitt was appointed a vice-president and Mr R W Vice took over as director of the National Institute for Telecommunications Research.

During the 1960s there was a gradual reorganization of government-supported research activities.

- The South African Wool Textile Research Institute, which had been registered as an autonomous co-operative industrial institute in 1954, was



Professor L J le Roux
Vice-President 1962–1965



Dr E J Marais
Vice-President 1962–1964



Dr F J Hewitt
Appointed Vice-President in 1964
Deputy President 1972–1980

taken over and managed directly under the CSIR in 1964. Dr C C Kritzinger resigned and Dr D P Veldsman was appointed director of the Institute.

- By mutual agreement between representatives of the Chamber of Mines, the steel wire rope industry, the Department of Mines and the CSIR, the Government Mechanical Laboratory was transferred to the CSIR. It was reconstituted as the Mining Equipment Research Unit of the CSIR's National Mechanical Engineering Research Institute on 1 April 1964.
- The Republic Observatory in Johannesburg which, since its establishment in 1908, had been administered by the Public Service, was incorporated into the CSIR in 1964 and the director, Dr W S Finsen, was seconded to the CSIR staff pending his retirement from the Public Service the following year.
- The Hermanus Magnetic Observatory which, since 1938, had been administered by the Trigonometrical Survey, was incorporated in the CSIR on 1 April 1969 with Mr A M van Wijk as head. He was succeeded by Dr G J Kühn in 1977.

Medical Research

At its inception the CSIR was entrusted with the responsibility for exploring and developing the whole field of medical research in South Africa. On the advice of the Medical Research Committee under the chairmanship of Professor S F Oosthuizen, president of the South African Medical and Dental Council and a council member of the CSIR, it was decided not to set up any medical research institutes but rather to support promising research at existing institutions. This was done by means of *ad hoc* grants to outstanding workers and by supporting units, groups and projects at universities and other institutions under the direction of leading medical scientists.

By 1969 the CSIR's annual commitment for the support of medical research had grown to R708 000. In addition, it administered R340 000 a year on behalf of other bodies interested in specific fields of medical research, including the Department of Mines and the gold and asbestos mining industries.

In view of the increasing complexity of the CSIR's involvement in the support of decentralized activities in the field of medical research, Dr W H Craib, a former professor of medicine at the University of the Witwatersrand, was appointed full-time associate adviser on medical research to assist the honorary adviser, Professor S F Oosthuizen and three part-time associate advisers, Professor J Barnetson, Professor H W Snyman and Dr R Alexander. Dr Craib was appointed a vice-president of the CSIR in 1965, a position from which he retired in 1967 pending the establishment of a separate Medical Research Council on 1 July 1969, in terms of the South African Medical Research Council Act (No. 19 of 1969).

Those divisions of the CSIR's National Nutrition Research Institute concerned with nutritional diseases were transferred to the Medical Research Council to form the National Research Institute for Nutritional Diseases, while those divisions concerned with food science and technology were reorganized as the National Food Research Institute of the CSIR. Dr J J Theron, who had succeeded Dr F W Quass as director of the CSIR's National



Dr W H Craib
Vice-President 1965–1967

Nutrition Research Institute in 1965, was appointed vice-president and chief executive officer of the MRC and for the time being acting director of the National Research Institute for Nutritional Diseases. Mr J P de Wit, formerly assistant director of the National Nutrition Research Institute, was appointed director of the National Food Research Institute of the CSIR in 1969.

Two important new facilities developed by the CSIR were commissioned during 1969, namely the Laboratory for Natural Isotopes and Geophysics of the National Physical Research Laboratory in Pretoria and the new laboratories in Stellenbosch of the Hydraulics Research Unit of the National Mechanical Engineering Research Institute, until that time based in Pretoria. A third important event was the commissioning of the research vessel, the *Meiring Naudé*, designed and built in Durban to the specifications of the NPRL for its Physical Oceanography Division.

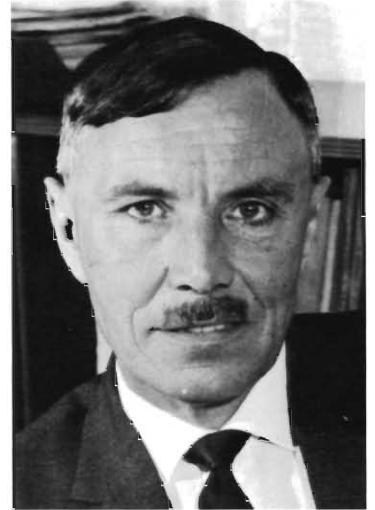
At the end of 1969 the Council suffered a severe loss when the deputy president, Dr N Stutterheim, resigned to take up an appointment in private industry. He had been vice-president since 1959 and was appointed to the new post of deputy president in 1967. He resigned 'in protest against the encroachment of civil service bureaucracy on this essentially research-oriented organization where independence of thought and freedom of action are paramount considerations.'^{*} He was succeeded as deputy president by Dr C v d M Brink, who had been appointed a vice-president of the CSIR in 1967 with a special responsibility for university research. Dr P J Rigden was appointed a vice-president in 1970 and was succeeded by Dr S H Kühn as director of the National Institute for Road Research.

In 1971 the executive of the CSIR was constituted as follows:

- Dr S Meiring Naudé (president),
- Dr C v d M Brink (deputy president),
- Dr F J Hewitt (vice-president),
- Dr P J Rigden (vice-president),
- Dr J F Kemp (appointed a vice-president in January 1971; former head of the Department of Mechanical Engineering at the University of Stellenbosch).

In the same year the Electrical Engineering Department of the National Research Institute for Mathematical Sciences became a separate institute – the National Electrical Engineering Research Institute with Mr J D N van Wyk, who had joined the staff of the NPRL in 1950, as its director.

A development of great importance to astronomical research in South Africa arose from a proposal by the British to combine the resources of the Republic Observatory in Johannesburg and the Royal Observatory in Cape Town. The outcome was an agreement between the CSIR and the Science and Engineering Research Council of Great Britain to establish a new institution to be known as the South African Astronomical Observatory under CSIR management. In view of the deterioration of observing conditions at the existing observatories which had been overtaken by urban



Dr P J Rigden
Vice-President 1970–1979



Dr J F Kemp
Appointed Vice-President in 1971
(Promoted Deputy President in 1980)

^{*} *Optima*, Oct. 1986, pp. 136–139



State President C R Swart unveiled a commemorative plaque at the CSIR on 9 August 1962, when he officially dedicated the CSIR laboratories and facilities to the advancement of science in South Africa.

25th anniversary

development, a new station much more favourable for astronomical viewing was established near Sutherland in the Cape in 1973. Sir Richard van der Riet Woolley, former Astronomer Royal of Great Britain, was appointed as the first director. He retired in 1976 and was succeeded by Dr M W Feast.

In 1970 the CSIR celebrated its 25th anniversary. At that time the organization consisted of 12 major national research institutes, four major service departments (Administrative, Technical, Estates and Information, the latter including four overseas offices), an associated autonomous Inventions Development Corporation and four co-operative industrial research institutes. The budget had grown to R2,6 million in 1955 (i.e. after 10 years), to R15,6 million in 1965 (i.e. after 20 years), and to R22,6 million after 25 years.

When Dr Naudé became president in 1952, the total budget of the CSIR was some R1 557 610, of which about 4,3 per cent was derived from investigations and tests undertaken under contract. When he retired in 1971, the equivalent amounts were R29,3 million and some 37,4 per cent. Even allowing for inflation, this represented a remarkable development, particularly in the proportion of the income derived from investigations and services. These statistics reflected not only the growth of the CSIR as a research organization but also, and more importantly, increasing competence in the ability to manage research on a large scale. They did not, however, reflect the full extent of the influence of the CSIR and particularly of its president on the development of science and technology in the country generally.

Despite his preoccupation with the development of the CSIR as a research organization, Dr Naudé devoted much of his time and energy to the fostering of university research, industrial research and international co-operation in science. Although assisted by vice-presidents such as

Dr W S Rapson and Dr E J Marais, he retained a direct involvement in the CSIR's support for the university research grant scheme until Dr C v d M Brink was appointed vice-president in 1967 with a specific responsibility for this function. The provision for university grants increased from R64 520 in 1952 to R1 329 300 in 1967.

Although no further co-operative industrial research institutes were established during Dr Naudé's term of office as president, those that had been established while Dr Schonland was president continued to make encouraging progress – the Leather Industries Research Institute under the founder director, Dr S G Shuttleworth; the Fishing Industry Research Institute under the founder director, Dr G M Dreosti, who retired in 1970, the Sugar Milling Research Institute under the founder Director, Dr K Douwes-Dekker, who retired in 1966; and the South African Paint Research Institute under Mr G M Hamilton, who took over from the founder director, Dr L R Whitby in 1952, and retired in 1971.

An Advisory Committee for the Development of Research for Industry (ACDRI) was set up under Naudé's chairmanship as early as 1958 to review the activities of these co-operative industrial research institutes and to recommend the level of CSIR financial support for five-year periods. On advice from the committee, a scheme for the establishment of industrial research units within the framework of existing national research institutes of the CSIR was introduced. This provided for the support of 'dedicated' continuing research by groups of sponsors on a co-operative basis without incurring the expense of setting up a separate institute. Among the more successful of the research units set up under this scheme in the early 1960s were the Timber Research Unit (under the National Building Research Institute), the Sorghum Beer Research Unit and a Microbiology Research Group (under the National Chemical Research Laboratory) and the Air Pollution Research Group (under the National Physical Research Laboratory). Naudé also actively supported the activities of the CSIR's regional research liaison committees in Natal, the Eastern Cape, Western Cape and South West Africa. Whenever possible he attended their meetings and took the chair himself.

During the early 1950s, the CSIR's involvement in international co-operation in science was focused mainly on Africa through the Scientific Council for Africa South of the Sahara (CSA). As has been mentioned, this body was set up following the African Regional Scientific Conference held in Johannesburg in 1949. As president of the CSIR, Naudé became a member of CSA and was later elected vice-chairman. Several of the CSIR's national research institutes – notably the National Building Research Institute, the National Institute for Personnel Research, the National Institute for Road Research and the National Institute for Water Research – became actively involved in CSA schemes for the exchange of information and expertise in the sub-Saharan region. When the CSA ceased to exist as a result of changing political circumstances in Africa, co-operation was continued largely on a bilateral basis.

In the 1960s the British Commonwealth provided a framework for scientific co-operation between the member countries of the Commonwealth. This

Research for industry

International co-operation

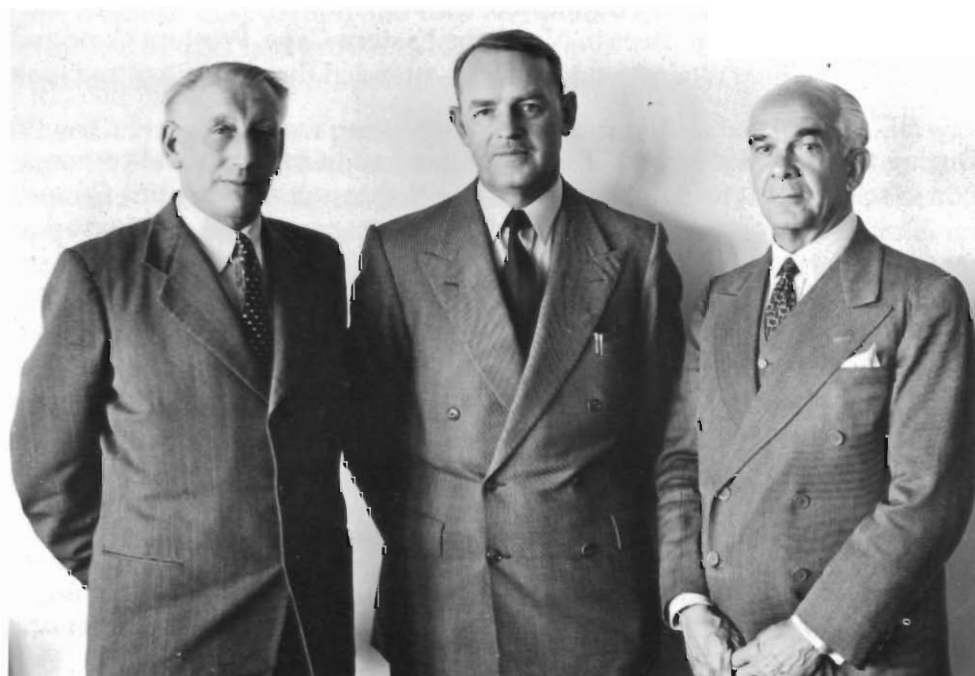
Liaison offices in West Germany and France

was facilitated by a so-called British Commonwealth Scientific Committee, the members of which were the heads of national research councils, i.e., bodies equivalent to the CSIR. Naudé regularly attended the meetings of this body which were held every two years in a different Commonwealth country.

During Naudé's period as president, South Africa's scientific representation overseas through the CSIR's scientific liaison offices in London and Washington DC was extended by the establishment of liaison offices in Cologne, West Germany, in 1957 (later moved to Bonn) and Paris in 1968. The role of these offices in serving not only the CSIR but also the universities, other scientific and technical agencies, industry and individual scientists and technologists became more clearly defined.

One of the main functions of the Paris office was to facilitate contacts with international scientific organizations, many of which had their headquarters in Paris. One of them was the International Council of Scientific Unions (ICSU), of which the CSIR had become the South African 'national member' in succession to the former National Research Council and Board. The success of the International Geophysical Years (IGY 1957–58) which was organized under the auspices of the ICSU and in which there was active South African participation through a 'national programme' organized by the CSIR, paved the way for several more international programmes under the ICSU's auspices during the 1960s. These included, for example, antarctic research, the International Quiet Sun Years (1962–63), the International Indian Ocean Expedition (1964) and the International Biological Programme (1969–72). To assist it in co-ordinating and funding participation in those activities by South African scientists and scientific organizations, the CSIR set up an Advisory Committee on International Co-operation in Science as

Dr S M Naudé, President (centre),
with his predecessors,
Dr B F J Schonland (left) and
Dr P J du Toit (right), in 1953



a national committee for the ICSU, with Dr Naudé as chairman. In addition, 'national committees' were set up for the various constituent scientific unions of the ICSU and its permanent interdisciplinary scientific committees. Several highly successful international scientific conferences and symposia were organized by the CSIR in South Africa under the ICSU's auspices and in accordance with the ICSU's principles that no bona fide scientist from any member country should be prevented from attending such meetings. The CSIR also funded attendance at general assemblies and other formal meetings of the various scientific unions, while Dr Naudé himself attended the two-yearly general assemblies of the ICSU.

While president of the CSIR, Naudé found time to be president of the South African Association for the Advancement of Science, the Associated Scientific and Technical Societies and the Suid-Afrikaanse Akademie vir Wetenskap en Kuns.

When he retired as president in October 1971 he had served the CSIR in that capacity for 19 years. He had led the CSIR with great distinction and left a flourishing research organization, poised for further development.

1971–1980

THE BRINK DECADE: Economic and environmental stresses

Naudé was succeeded by Dr Chris van der Merwe Brink who, before joining the CSIR as a vice-president in 1967, had had a long and distinguished career as a research chemist at Iscor. He had also been a senior lecturer at the University of Pretoria and professor of Organic Chemistry and head of the Department of Chemistry at the University of the Orange Free State. In 1970 he had been appointed deputy president of the CSIR and when he became president he was succeeded as deputy president by Dr F J Hewitt. Under their leadership the tempo of development of the CSIR was maintained, with the emphasis on the involvement of research workers at universities and other organizations in national and international research projects.

At the international level the next 10 years were marked by increasing concern for the protection of the environment, by the so-called energy crisis of 1973 onwards, galloping inflation, increasing unemployment in Western Europe and North America and other symptoms of economic recession. These factors, in striking contrast with the spectacular technological and economic success of Japan, tended to create a mood of gloom in the West. Coupled with this, the excesses of the environmental lobby found expression in strong anti-nuclear protests, amongst other things. This tended to generate disenchantment with science and technology which further inhibited economic development. The failure of foreign aid programmes to alleviate the development problems of the Third World also contributed to a diminishing faith in a future based on technology. In this situation were to be found the ingredients of political confrontation between the 'North and South', and the Third World countries sought their own advantage in exploiting existing tensions between West and East.



Dr C vd M Brink
President 1971–1980

Tensions and challenges

Nowhere were these tensions brought into sharper focus than in South Africa, with its First World/Third World economies existing side by side, with agricultural, industrial and technological revolutions all going on at one and the same time. The inevitable consequence of this situation, with people in a rapid state of transition from a rural to an industrialized society, was manifested in the well-known sociological problems of urbanization coupled with rapid population growth, particularly among the poorer sections of the population. The imperatives of the time were job creation, the provision of low-cost housing, and the development of an infrastructure – roads and transport, power supply and distribution, water supply and effluent treatment, health services and, above all, education and training.

In addition to making a contribution to the solution of these problems through the application of scientific research, the CSIR was expected to provide back-up to the high-technology component of major manufacturing industries, on whose competitiveness the country was dependent for continued economic growth.

In facing up to these challenges, the public and the private sector tended to be hampered rather than assisted by foreign intervention in the form of prescriptions for political reform, the setting of time tables, embargoes on equipment, and other steps aimed at the isolation of South Africa in a variety of fields. In this situation, the role of the CSIR was focused on finding acceptable technological solutions to socio-economic problems related to improvement in the quality of life of all sections of the population.

As president, Dr Brink devoted his energies, considerable gifts of personality, his skills as a manager and negotiator and his comprehensive scientific knowledge, to ensuring the effective involvement of the CSIR in all fields appropriate to its mandate. In doing so, he was concerned more with the consolidation, development and rationalization of the organization he took over and with building up international contacts, rather than with essentially new developments.

The scope of the South African Wool Textile Research Institute was extended to include research and development on the processing of all textile fibres – animal, vegetable and synthetic – and blends of these fibres. It thus became a national textile research institute in the fullest sense in 1971. Its name was changed to the South African Wool and Textile Research Institute, thus retaining the acronymic title of SAWTRI, and as such became fully operative when Dr Brink officially commissioned a new cotton processing department in 1974.

A development of considerable significance in 1971 was the establishment of the Water Research Commission. Through this body a mechanism was created for reviewing and funding all aspects of water research in South Africa. The internationally recognized pioneer of water treatment research, Dr G J Stander, founder director of the National Institute for Water Research, was appointed vice-president and executive officer of the commission. He was succeeded as director by Dr G G Cillie, head of the Institute's Regional Research Laboratory at Bellville, Cape.

In 1972 Dr P C Carman retired. He had joined the staff of the National Chemical Research Laboratory when it was established in 1947 and suc-

ceeded Dr W S Rapson as director in 1958. Under their leadership, which lasted 25 years, the NCRL became a focus for fundamental chemical research related to the needs of industry and to the biomedical field, a field in which it won international recognition. Another stalwart to retire in this period (1974) was Dr Stanley Shuttleworth, the founder of the Leather Industries Research Institute, Grahamstown. Generally regarded as one of the pioneers of industrial research in South Africa, he had played an important role in the establishment of co-operative industrial research institutes under the 'research association' scheme introduced by the CSIR in 1945.

One of the highlights of 1973 was the formal opening on 1 March of the observing station at Sutherland of the South African Astronomical Observatory (SAAO) by the Prime Minister, Mr B J Vorster. Guest of honour at this function was Mrs Margaret Thatcher, at that time Secretary of State for Education and Science in Britain.

In the same year the Chemical Engineering Research Group, which had been developed by the NCRL, became a separate entity under Mr W G B Mander-sloot. Dr T Hodgson, head of the Heat Mechanics Division of the NMERI, was appointed director of the Technical Services Department following the retirement of Mr J van der Staaij who had been director since its formation in 1963.

Dr A P Burger, who had been director of the National Research Institute for Mathematical Sciences since its establishment as a separate institute of the CSIR in 1961, was appointed a vice-president of the CSIR in March 1973. In this position Dr Burger had a special responsibility for university research grants. In January 1977 he left the CSIR on being appointed scientific adviser to the Prime Minister after the retirement from that position of Dr S Meiring Naudé. Dr D M Joubert of the University of Pretoria was appointed a vice-president in his place.

The importance of oceanology to South Africa with its 3 000 km of coastline facing the Indian, Atlantic and southern seas was recognized with the establishment of a National Research Institute for Oceanology in 1974. It was based at Stellenbosch and combined the Division of Physical Oceanography of the CSIR's National Physical Research Laboratory (based in Natal), the Hydraulics Research Unit of the CSIR's National Mechanical Engineering Research Institute (based in Stellenbosch), and groups supported by the CSIR at the University of Cape Town. These units had pioneered the development of major fields of marine science in South Africa. Professor E S W Simpson, professor of geology at the University of Cape Town, who had a primary interest in marine geology, was appointed director, but he resigned in 1976 to take up the chair in oceanography at the University of Cape Town. He was succeeded by Mr F P Anderson who had been head of the Division of Physical Oceanography from the time when that activity was initiated in 1954.

When in 1975 the National Institute for Telecommunications Research moved from the campus of the University of the Witwatersrand to new laboratories situated on the hilltop site formerly occupied by the Republic Observatory in Johannesburg, the Minister of Planning, Mr J J Loots, unveiled a plaque commemorating the dedication of the site to the service of



Dr A P Burger
Vice-President 1973–1976



Dr D M Joubert
Vice-President 1977–1978

science for more than 70 years. At that time, the institute was undergoing a major reorientation as a result of the decision by the National Aeronautics and Space Administration (NASA) of the United States of America to phase out the operation of the Deep Space Instrumentation Facility for tracking space probes, and the station of the Spaceflight Tracking and Data Network. These facilities had been operated, as a major undertaking, by the institute under contract to NASA at its Radio Space Research Station at Hartebeesthoek from 1961. The termination of these contracts involved considerable redeployment and retrenchment of specialist staff. The CSIR entered into an agreement with the French Centre National d'Etudes Spatiales (CNES) in terms of which the National Institute for Telecommunications Research would assume full responsibility in 1973 for operating, on behalf of CNES, the French Satellite Tracking Station at Paardefontein near Pretoria. With the NASA equipment which the NITR retained and with a special grant from the Treasury, the NITR was able to apply the expertise gained over the years in satellite tracking to receiving remote sensing data directly from European and American satellites, by agreement with the agencies concerned, for processing in South Africa. From the beginning of 1978, images were received from the European meteorological satellite METEOSAT, processed at Hartebeesthoek and transmitted by landline to the Weather Bureau. The 26-metre parabolic antenna of the Deep Space Instrumentation Facility also became fully available for radio astronomy observations and it was decided to take advantage of this to develop a Radio Astronomy Observatory (as it came to be known) at Hartebeesthoek under Dr G D Nicolson.

*Assistance for small
and medium-sized
firms*

Under Dr T Hodgson, director of the Technical Services Department, a Production Engineering Advisory Service based on the expertise and specialized facilities of the department, was established in 1975. One of the primary aims of the service was to assist small and medium sized firms, particularly in the metal working industries, to take advantage of new technological developments. Their main needs were identified as being in the field of technology transfer rather than in research and development.

The South African Paint Industries Research Institute in Durban made valuable contributions to establishing a sound technological base for the paint industry in this country. However, when the industry refused to increase its annual contributions to a level considered to be appropriate for maintaining a viable level of research activity, it was decided in 1975 that the Institute should close.

*Co-operative Scientific
Programmes*

A separate unit called the Co-operative Scientific Programmes, reporting directly to the president, was established in 1975 to manage national scientific programmes. By 1980 there were active national co-operative scientific programmes in the fields of antarctic, earth, marine, atmospheric, space, environmental, materials and energy research. It was claimed that about 600 individual research workers from some 80 South African research organizations were involved in these programmes. Their work had previously been co-ordinated by the Information and Research Services as the concept had originated during the 1960s within the framework of international scientific programmes initiated by the International Council of Scientific Unions (ICSU).

Following an exchange of visits between the president of the Senate in Iran and Dr Brink, the CSIR in 1975 established a scientific liaison office in Teheran. The office, under Mr G A Harvey, was attached to the office of the South African Consul-General. This interesting experiment in bilateral co-operation in science and technology between two countries with many similarities in socio-economic circumstances came to an end in 1979 as a result of changes in the political situation in Iran. In the same year an agreement was concluded between the National Council for Research and Development of Israel and the CSIR. This provided, among other things, for the mutual exchange of research workers in various fields of science and technology, and an annual symposium to be held alternately in Israel and South Africa.

CSIR research into the better use of locally grown timber had developed to such an extent by 1976 that the Timber Research Unit became the National Timber Research Institute. The head of the unit, Dr D L Bosman, was promoted to director. Originally established in 1960 under the wing of the National Building Research Institute, the Timber Research Unit had operated as a separate entity since 1966, serving the rapidly developing timber, pulp and paper industries.

To give effect to the recommendations of the Driessen Commission of Inquiry into Urban Transport Facilities, published in 1975, the scope of the National Institute for Road Research was extended to include investigation of problems related to transport planning, traffic control and transport data. The following year the Institute was renamed the National Institute for Transport and Road Research.

Recommendations initiated by the South African Institute of Physics and individual scientists on the need for a nuclear accelerator in the Western Cape, were accepted by the Government. In 1977 it assigned responsibility for the development and operation of such a centre to the CSIR. To meet this commitment the CSIR formed a new national institute to be known as the National Accelerator Centre, with Dr G Heymann, head of the Nuclear Physics Division of the National Physical Research Laboratory, as director. The new institute would combine the existing cyclotron and related facilities of the National Physical Research Laboratory in Pretoria with the planned new accelerator facilities at Faure in the Western Cape, to be situated adjacent to the existing Southern Universities Nuclear Institute.

In 1978 the Aeronautics Research Unit, which had been developed under the National Mechanical Engineering Research Institute during the 1950s, was transformed into a new National Institute for Aeronautics and Systems Technology under Dr T J Hugo, director of the former National Institute for Defence Research. The CSIR's computing facilities and the demand for these services had grown to such an extent that the computing centre was separated from the National Research Institute for Mathematical Sciences in 1979. It thus became a national institute known as the Centre for Computing Services, with Dr E N van Deventer as director. When Dr D P Veldsman, who had been director of the South African Wool and Textile Research Institute since its incorporation by the CSIR in 1964, resigned in 1979 to take

up an appointment as director of the Port Elizabeth Technikon, he was succeeded by Dr D W F Turpie.

A National Calibration Service was formally established within the framework of the National Physical Research Laboratory in 1980. The purpose of this service was to authorize various organizations to undertake calibrating services traceable to the national measuring standards maintained by the NPRL.

In 1975, the CSIR's central library and associated information services were grouped together to form a national Centre for Scientific and Technical Information. This gave recognition to the rapid growth and increasing sophistication of these services, which were in line with similar developments in the industrialized countries. Although the centre acquired a separate identity, it continued to operate within the framework of the CSIR's Information and Research Services until 1980 when it became a separate national institute of the CSIR. The head of the centre, Dr R van Houten, a graduate electronics engineer with a doctorate in business administration, was promoted to the rank of director. The Information and Research Services continued to focus attention on:

- International scientific co-operation through scientific liaison offices overseas, bilateral agreements, the International Council of Scientific Unions and its constituent international scientific unions and interdisciplinary scientific committees;
- Techno-economic studies particularly in relation to technological innovation in industry; and
- All aspects of scientific and technical communication, including publicity and publishing, conferences and symposia, management of the CSIR Conference Centre and a visitors reception office.

In this and related contexts a suitable venue for conferences, symposia, seminars and audiovisual presentations to groups of visitors became increasingly necessary. This need was met when the CSIR Conference Centre was opened in 1977 – the culmination of a project in which Dr Brink took particular pride and pleasure. The centre was also available to other organizations with interests related to those of the CSIR.

Substantial growth and development

By 1980 the annual budget of the CSIR amounted to R102,9 million, of which some 26,4 per cent was derived from sources other than the parliamentary grant (as compared with R29,3 million and 37,4 per cent when Brink took over in 1971). Even taking into account such factors as inflation and the increasing capital costs of research attributable to the enhanced sophistication of scientific instrumentation, this represented substantial real growth and notable developments in all fields of CSIR activity under Brink's dynamic leadership.

The unexpected death of Dr Brink in May 1980, at the height of his powers left the CSIR temporarily floundering and without direction. As Dr Rigden had retired in December 1979 and the deputy president, Dr Hewitt, in March 1980, Dr C F Garbers as acting president found himself at the head of a team in which only Dr J F Kemp had had more than 18 months' experience on the executive.

1980–

ENTER GARBERS: A time for change

The CSIR Council and the Government moved quickly to rectify this situation. In May 1980 Dr Garbers was appointed president. His distinguished career in research started with a DPhil (*cum laude*) at the University of Zurich (1951–1954) under Professor P Karrer, a Nobel Laureate. After spending four years on the research staff of the National Chemical Research Laboratory of the CSIR, he became professor of organic chemistry, and also head of the CSIR's Polyene Chemistry Research Unit at the University of Stellenbosch.

In January 1979 he joined the CSIR executive as a vice-president (with a special responsibility for university research) when Dr D M Joubert was appointed vice-rector and rector designate of the University of Pretoria. He and Dr J F Kemp, a vice-president since 1971, became deputy presidents in April 1980 following the retirement of Dr Hewitt.

The other two members of the executive were Mr J P de Wit, former director of the National Food Research Institute, and Dr E N van Deventer, former director of the Centre for Computing Services, who had taken up their appointments in 1979 and 1980, respectively.

The new vice-presidents, whose appointments had been approved before Dr Brink's death, were Professor D H Jacobson and Dr G Heymann (1980). Professor Jacobson had joined the CSIR in January 1975 as director of the National Research Institute for Mathematical Sciences, while remaining honorary professor in applied mathematics at the University of the Witwatersrand. Dr Heymann, a physicist, was head of the Nuclear Sciences Group of the National Physical Research Laboratory from 1960 to 1977 when he became director of the newly established National Accelerator Centre. Professor R R Arndt joined the executive in 1981 and succeeded Dr Garbers in carrying special responsibility for university research. He was professor of organic chemistry at the Rand Afrikaans University and from 1979 at the University of Stellenbosch.

With this young and relatively inexperienced team, Dr Garbers found himself suddenly precipitated into a situation in which he had to take up the reins as head of the complex CSIR organization which had been going ahead with verve and vigour under the guiding hand of Dr Brink.

It is evident that Dr Brink had visualized this as a time for change and renewal. Dr Garbers had perforce to carry forward the initiatives which had already been set in motion, but it was inevitable that there should be a steadying of the pace – a breather for taking stock of the situation and adapting to changing external circumstances.

These continued to be dominated by factors such as persistent inflation, worldwide recession, the aftermath of the energy crisis, the weakening price of gold and the onset of severe drought. In a rather special way the CSIR found itself called upon, in this situation, to service the high-technology component of the economy for the generation of wealth to finance develop-



Dr C F Garbers
Appointed President in 1980



Mr J P de Wit
Appointed Vice-President in 1979
(Deputy President 1983–1985)



Dr E N van Deventer
Appointed Vice-President in 1980
(Promoted Deputy President in 1983)



Professor D J Jacobson
Appointed Vice-President in 1980
(Deputy President 1983–1985)



Dr G Heymann
Appointed Vice-President in 1980
(Promoted Deputy President in 1983)



Professor R R Arndt
Appointed Vice-President in 1981
(Promoted Deputy President in 1983)

ment, and to extend the benefits of research to improve the quality of life of all sections of the population. In a sense, the dilemma of the 'dual economy' of countries such as South Africa accentuated the need for an imaginative strategy for planning the future development of the CSIR.

One of the first tasks facing this new executive in 1980 was the replacement of a number of directors of the CSIR's national research institutes who had either been promoted to the executive or who had retired. Mr V A Shaw was appointed director of the Centre for Computing Services, Dr D Reitmann (previously of the Atomic Energy Board) director of the National Accelerator Centre, Dr D H Martin director of the National Research Institute for Mathematical Sciences, and Mr J F van Straaten director of the National Building Research Institute in succession to Dr T L Webb who had retired after holding the post for 22 years. At the end of the year Dr H G Denkhaus who had been director of the National Mechanical Engineering Research Institute since 1959, also retired, and was succeeded by Dr M S Hunt who had joined the Institute in 1971. In 1981 Mr G W Donaldson, who had been assistant director of the National Building Research Institute, was appointed director of the Estates Department which is responsible for building and site services in the CSIR organization. Mr A Krüger, who had been manager of the department since 1968, had died earlier in the year. When Mr A M Schady, who had been manager of the South African Inventions Development Corporation since 1962, retired in 1982, he was succeeded by Mr A A de Waal.

In the international field further steps were taken to foster mutual interest with other countries. A bilateral agreement between the CSIR and the National Science Council of the Republic of China in 1980 provided, among other things, for the exchange of research workers. The existing agreement with the National Council for Research and Development (NCRD) of Israel (see p. 60) was extended to accommodate collaborative research projects, the first two of which were initiated in 1983. Scientific representation in North America was extended when a second American liaison office was opened in Los Angeles in 1980 under Mr N C Hauffe.* In Southern Africa a liaison office was established in Windhoek under Dr D H R Hellwig, formerly head of the CSIR's Scientific Liaison Office in Bonn, West Germany.

In terms of an agreement with the United States National Oceanic and Atmospheric Administration (NOAA), the Satellite Remote Sensing Centre at Hartebeesthoek was recognized as a regional centre for Landsat data, as such receiving and distributing imagery covering most of Africa south of the Equator, both locally and abroad. In terms of an agreement with the French Centre National d'Etudes Spatiales (CNES), the Satellite Tracking Station at Paardefontein was transferred and integrated with the Satellite Remote Sensing Centre at Hartebeesthoek and became operational in 1982 under Mr W J Botha of the NITR.

Developments singled out for special mention by the president in the CSIR's Annual Report for 1982, included the following:

* This office was discontinued in 1985.

- As a result of a decision by the Cabinet, responsibility for the Fuel Research Institute (established in 1930 as an autonomous statutory body under the Fuel Research Board) was transferred to the CSIR in 1982 with Dr T C Erasmus as director. (Following an amendment of the relevant legislation, the institute was renamed the National Institute for Coal Research and incorporated into the CSIR in 1984.)
- The Treasury approved funds for building a test facility for fluidized-bed combustion of coal with a high ash content, with the object of developing techniques for the efficient combustion of this type of coal.
- Incorporation of the Southern Universities Nuclear Institute (SUNI) into the CSIR, to be run as an integral unit of the National Accelerator Centre.
- Establishment of a Traffic Information Bureau to be run by the National Institute for Transport and Road Research on behalf of the Department of Transport.

The intensive internal review initiated in 1980 by the new executive, covering all aspects of CSIR activities, began to show results in organizational changes and new developments in the period 1983 to 1985.

In 1984 it was decided to combine the Research Grants Division and the Co-operative Scientific Programmes to form a new organization to be known as the CSIR Foundation for Research Development under Dr R R Arndt, a member of the CSIR executive. This reorganization was based on the recommendations of an enquiry undertaken on behalf of the CSIR by Professor J F de Wet, former dean of the Faculty of Science at the University of Cape Town.

At the end of 1982 Dr A Strasheim retired after being director of the National Physical Research Laboratory for 20 years and was succeeded by Dr J S V van Zijl. Material science which had been strongly developed within the framework of the National Physical Research Laboratory under Strasheim, was regrouped with related activities within the CSIR to form a new National Institute for Materials Research under Dr J B Clark as chief director in 1983. In the same year Dr J R Bull was appointed chief director of the National Chemical Research Laboratory (NCRL) on the retirement of Dr P R Enslin.

Resulting from an investigation into research and development requirements in the new field of biotechnology, a Laboratory for Molecular and Cell Biology was established at the University of the Witwatersrand under Professor Jennifer A Thomson in October 1983. Training programmes for high-level research manpower in this field were also projected for the Universities of Cape Town, Potchefstroom and the Witwatersrand, as well as at the Veterinary Research Institute at Onderstepoort.

In 1984 Dr G G Cillié retired as chief director of the National Institute for Water Research and was succeeded by Dr D F Toerien. In the same year the Production Engineering Advisory Service (PEAS), under Dr T Hodgson, was transferred from the Technical Services Department to become a unit of the National Mechanical Engineering Research Institute. This reorganization reflected the continuing commitment of the CSIR to expand the activities of PEAS to meet the broader technology transfer needs of local industry.

Establishment of Foundation for Research Development

Mr P Lasserre succeeded Dr Hodgson as director of the Technical Services Department. In another reorganization following the retirement of Dr R van Houten, the Centre for Scientific and Technical Information was combined with the Centre for Computing Services to form a National Institute for Informatics under V A Shaw as chief director.

In the eighties the CSIR and the Human Sciences Research Council (HSRC) reviewed the wide-ranging activities in the human sciences of the National Institute for Personnel Research (NIPR) as an institute of the CSIR relative to the mandate of the HSRC. With government sanction the NIPR's transfer to the HSRC became effective on 14 June 1985.

Dr L R P Butler, formerly of the National Physical Research Laboratory and head of the Scientific Liaison Office in Bonn, West Germany, took over as director of the Information and Research Services at the beginning of 1984 following the retirement at the end of 1982 of Mr D G Kingwill, who had been on the staff of the CSIR since its inception. After retirement, he continued as acting director for another year. Dr J Morris was appointed director of the National Building Research Institute on the retirement of Mr J F van Straaten in the same year.

Adapting to meet new challenges

The CSIR at this stage was in a state of reassessment and adaptation to meet the challenges of a period of rapid change. Some of these challenges, as seen by the president, Dr Garbers, are reflected in the following public statements made by him in the period 1984–1985:

- 'Worldwide, the First World technology-based countries are investing heavily in science and technology, as a means to find their way out of their economic difficulties and to establish their technological supremacy in the eighties and nineties. Consequently, global recession has led to an increase rather than a decrease in research spending. The gap between the First and the Third World has widened. With new highly sophisticated technologies like robotics, genetic engineering and advancement in telecommunications and the computer sciences, real advancement in Third World countries, without elements of "technological colonisation" is difficult to imagine.'
- 'An analysis of conditions in the majority of independent African States has shown that they have certain similarities, such as their relatively small populations, their lack of scientists and trained manpower and their political vulnerability because of their ethnic diversity. It is doubtful whether the scientific and technological infrastructure required for well ordered economic development can be created in these States in the foreseeable future, unless Western sources of technology are systematically tapped. In this regard the CSIR can make a valuable contribution, gained from its vast experience as a major force in development during its 40 years of existence in a country in which the First and Third Worlds are inextricably blended.'
- 'In carrying out its task, the CSIR has developed from its modest beginnings in 1946 into a nationally and internationally respected research organization which can keep pace with the country's scientific and technological demands. The CSIR should be regarded 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.'

In an overall review of the costs and the benefits of CSIR research and development, Dr Garbers drew attention to the following:

- 'The income of the CSIR for 1984–85 is approximately R180 million. Of this income, roughly 35 per cent was earned by direct contract with industry and government departments. If one takes inflation into account the real income shows very little true growth since 1975–1976. The engineering and the technological sciences receive the biggest slices of this cake. The rest is dedicated to investigations in the more fundamental sciences. Although high level manpower is a limiting factor, an improvement in research support generally and support of technology and the transfer of technology requires continued urgent attention.'
- 'Calculations show that implementation of recent research findings, disregarding the contributions from the past, implemented on a nationwide basis, should yield an estimated benefit of R681 million per annum. This estimate does not include benefits arising from smaller projects or projects for which it is not easy to calculate monetary benefits, e.g., improvements in working conditions and the quality of life. To these should be added the benefits which would not result in monetary advantage but are of crucial importance, such as conservation of our scarce resources (water), knowledge and understanding of the environment, the saving of human lives, essential services without which industry would not be able to function effectively, the provision of information, knowledge and know-how which is so important to the future.'

Be that as it may, during the first half of the eighties attempts were made by the Public Service to exert greater administrative control over the CSIR. This was strongly resisted by the CSIR's Council and Executive. The political unrest of 1983–1985 also precipitated measures to curb government expenditure and improve productivity in activities partially or totally funded by the Government. In response to substantial budget cutbacks the Executive decided against a policy of 'equal misery to all'. Instead, detailed studies were commissioned on which activities were to be closed, phased out, scaled down, strengthened, initiated or transferred to other organizations. Funds saved by closing activities were reserved for retraining of staff or training in management.

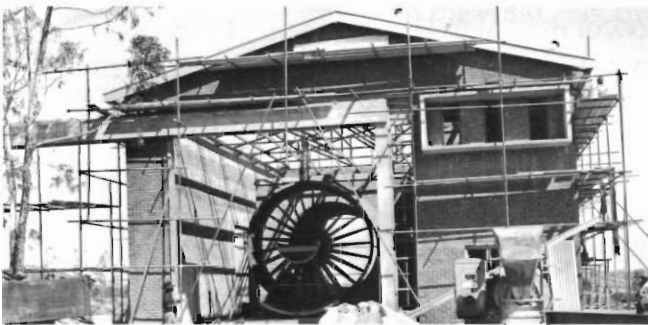
In February 1983 a study group under the chairmanship of Dr S J Kleu of the Board of Trade and Industries, published a report on industrial development strategy. This was followed by a 'White Paper on Industrial Development Strategy in the Republic of South Africa' in May 1985, extending challenges to the CSIR particularly with regard to the transfer of technology to the public and private sectors.

In June 1985 the Council approved the appointment of consultants for a management review of the CSIR and in August 1985 in an historic event the CSIR top management considered a change in direction for the CSIR. This decision heralded a new era in the development of the CSIR.

White Paper on Industrial Development Strategy



circa 1954



circa 1966

These photographs depict various stages in the development of the CSIR's Scientia campus in Pretoria. The building above, that for a 3 m wind tunnel, was the first to be built on the site. It was occupied in 1953.



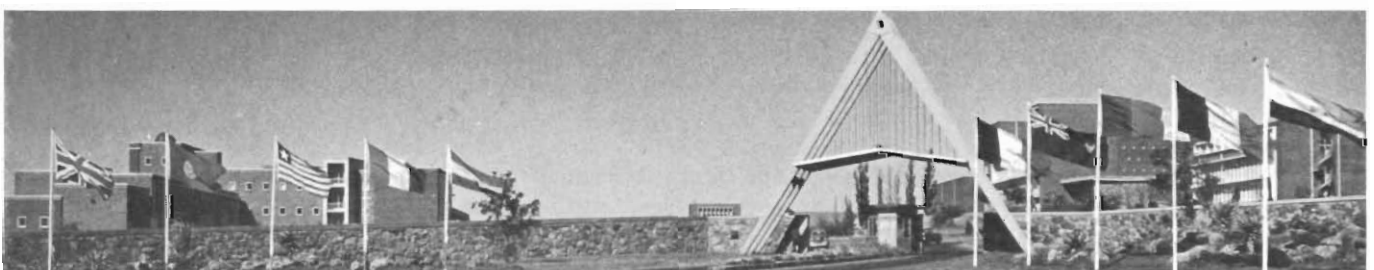
circa 1956



circa 1979



circa 1984



circa 1974

PART 2

The CSIR as a National Council for Science and Technology

It is evident that the founder president of the CSIR, Dr Basil Schonland, attached great importance to the co-ordinating and advisory function of the new organization. According to the provisions of the Act under which it was established, the CSIR would 'advise the Minister on all questions of scientific and technological methods affecting the utilization of the natural resources of the Union and the development of its industries and of the proper co-ordination and employment of scientific research to those ends.'

In a paper presented to the South African Institution of Engineers in Johannesburg in 1948, he said: 'Until recently we have not developed either university or government sponsored research or industrial research on a scale anything like that which is taking place overseas. One per cent of our national income would be some £14m per year; we are spending not much more than a sixth of this figure on all types of research – university, government and industrial. The CSIR was set up in 1945 to remedy this position.'

In terms of its statute, and in actual fact, the CSIR controlled a 'national research organization' and served as a 'national research council'. The national research institutes and associated services operated, in effect, as a contract research organization. As a 'national research council', the CSIR, in addition to its advisory and co-ordinating functions, was concerned with the support and development of scientific and industrial research in the country generally. It is to be doubted whether the senior staff of the national laboratories and institutes of the CSIR fully appreciated the implications of this dichotomy.

The objects of the CSIR which are relevant to its functions as a national research council as opposed to a national research organization are to be found in the Research Council Act (as amended) in the following clauses:

- 4(1)(a) to promote the utilization of the natural resources of the Republic and the productive capacity of its population;
- (g) to foster the training of research workers and to establish and award research bursaries;
- (h) to encourage and promote scientific research generally, and to contribute thereto financially;
- (i) to foster, recognize and aid the establishment of associations of persons engaged in industry for the purpose of carrying out scientific and industrial research, and to co-operate with and, subject to the conditions approved by the Minister, make grants to such established or recognized associations;
- (j) to establish and control facilities for the collection and dissemination of information in connection with scientific and technical matters;

The research council mandate

- (k) to act as liaison between the Republic and other countries in matters relating to scientific and industrial research.
- 4(2)(a) make grants to universities, museums, technical colleges and scientific institutions in aid of scientific and industrial research by their staff or for the establishment of facilities for such research;
- (b) co-operate with State Departments, universities, technical colleges, scientific institutions and other persons for the promotion of scientific and industrial research;
- (c) co-operate with educational authorities and scientific or technical societies in the Republic or organizations or bodies in the Republic representing employers and employees, respectively, for the promotion of –
 - (i) the teaching of science in schools, technical colleges and universities;
 - (ii) the training of research workers in science and of technical experts; and
 - (iii) the training of craftsmen and skilled artisans;
- (d) grant or make available bursaries and educational loans to persons desiring to train as scientists, technical experts, craftsmen or skilled artisans;
- (e) co-operate with persons and associations undertaking scientific or industrial research in other countries.

Main fields of activity

This advisory role was diluted somewhat when, in 1950, ministerial responsibility for the CSIR was transferred from the Prime Minister to the Minister of Economic Affairs, and still further with the appointment in 1962 of a scientific adviser to the Prime Minister and the Scientific Advisory Council. Nevertheless, there were six functions which the CSIR continued to develop strongly, acting in all respects as a national research council. They were:

- support and development of university research;
- development of medical research;
- promotion of international co-operation in science (at the non-governmental level);
- support and development of industrial research;
- dissemination of scientific and technical information; and
- support and co-ordination of national co-operative scientific programmes.

Each of these fields had its own advisory committee, namely –

- the National Research Awards Committee;
- the Committee of Research in the Medical Sciences (1945–1969);
- the Advisory Committee for International Co-operation in Science;
- the Advisory Committee for the Development of Research in Industry;
- the Advisory Committee for Information and Documentation; and
- separate national committees for Co-operative Scientific Programmes, e.g. the South African National Committee for Oceanographic Research and the South African National Committee for Geomagnetism, Aeronomy and Space Science.

'Trust funds' for these activities were managed separately from the general CSIR budget, and it was an unwritten rule that under no circumstances could money be diverted from these funds to support research activities in the CSIR organization. This did not apply to the co-operative scientific programmes which, particularly in later years, were funded from various sources and supported those best qualified to undertake research for a specific programme.

For the development of these extramural activities, the CSIR established a Liaison Division. This later became known as the Information and Research Services, incorporating library and information services 'for the collection and dissemination of information in connection with scientific and technical matters' in accordance with the provisions of the Act.

University research

In giving effect to these wide-ranging functions of the CSIR, Schonland gave priority to the support and development of university research. Acutely aware that the great traditions of independent thought and research had been nurtured by the universities down the centuries, through many vicissitudes of political and social change, he set about the task with great circumspection and was careful to avoid any suggestion that university research should be dominated by the CSIR. As he put it in an address to the South African Institute of Engineers: 'I should like to emphasize that it is undesirable that universities should look to the State, even as represented by a body like my Council, for the sole support of their research activities.'

In the same address he discussed his views on the need for supporting basic research at the universities:

'The mushroom growth of industrial research and government laboratories has everywhere had an effect on this great tradition of scholarship. None of the great developments of applied research during the last war was based on new fundamental scientific ideas. They represented great advances in science, engineering and technology but nothing more. The present call for more and more men for industrial research means that universities lose the men who will be the great teachers and scholars of the future. If such a state of affairs were to continue, applied research and technology would dry up, having used the intellectual capital provided by the scholars.

'There are three ways of remedying the dangers inherent in this situation. The first, and clearly the most important, is to support university scholarship and research sufficiently to ensure that it can continue to flourish and to make careers in university research attractive to first class brains. The second is to place applied research of the long-range type in close contact with universities so that industrial research institutes are on the campus though not necessarily part of the university itself. The third is to bring the growing national state research laboratories in some way in closer contact with universities.

'When a country like ours has 10 separate university departments of chemistry, physics, botany, zoology, and so on, and three or more schools of medicine and engineering, how can we possibly ensure that each is to be a modern research school with all the staff and equipment that is implied? What I would suggest would be to divide these expensive research schools among the universities of a country such as ours, on as fair a basis as possible. We should, I think, associate the national research laboratories with the universities in such a scheme.'

Scheme for university research grants

Against this background a scheme for Consolidated University Research Grants, devised by Schonland, was launched with great vigour and enthusiasm during the first year of the CSIR's existence. The scheme provided for the funding of senior research bursaries, postdoctoral, post-MSc and MSc bursaries, skilled and unskilled research assistantships as well as grants for running expenses and specialized items of major equipment, such as instruments, which did not form part of normal laboratory equipment.

It was a requirement that applications for the support of postgraduate research should be screened by research committees of the relevant universities before submission to the CSIR. Before being finally considered by the CSIR, they were sent to referees selected for their specialized knowledge of the subjects concerned. Each university then received a consolidated grant, representing the total value of all approved applications submitted by it, and was responsible for administering the individual awards. This scheme worked smoothly and did much to stimulate the postgraduate training of research workers who were urgently needed by the Government, by industry and by the universities and other research organizations throughout the country.

In 1946, the total amount budgeted by the CSIR for university research grants was £27 800, but applications received amounted to only £16 526.

In 1948, 62 bursaries for the support of research workers, 16 grants for the provision of technical assistants and a considerable sum for the purchase of equipment and the running expenses of university research were made available. By 1962, however, the CSIR's budgetary provision for this purpose was R299 754 whereas applications amounted to R537 338. These figures illustrated the extent to which research at the universities had been stimulated, and regrettably outstripped the rate of increase in the available funds. As a result more and more deserving applications had to be refused.

This was partly attributable, firstly, to the failure of the universities to make adequate provision for research from their own resources, secondly to the fact that, since 1955, the CSIR's total parliamentary grant had been limited by the Treasury to an annual increase of 7,5 per cent (excluding funds for special projects) and the CSIR had therefore been obliged to apply the same limits, on the 1955 base, in apportioning funds for university grants. From that stage onwards these were regarded by the CSIR as 'trust funds' (see page 44). Some alleviation was provided by special allocations by Treasury of R20 000 in 1961 and a further R125 000 in 1964 and R250 000 (non-recurring) in 1968.

In view of this situation, the CSIR in 1961 started discussions with the universities on the organization and administration of research grants. In addition to the inadequacy of the funds available for the support of university research and the need to provide adequate financial inducements for students to undertake postgraduate studies, these discussions highlighted the desirability of closer liaison between the CSIR and the universities, and the need to support on-going research in centres of excellence at the universities.

To meet the latter requirement of long-term research, including the necessary research assistants, accommodation and equipment, the CSIR's

Research Unit Scheme (which had been developed with great success in the field of medical research) was extended to the other sciences. These units superseded a senior research fellowship scheme which had enabled recognized senior research workers to devote two or three years to full-time research. For the most part these research fellowships had been awarded to biologists who did not need expensive or elaborate equipment to round off research in which they had been engaged for many years. A system of so-called 'directed research bursaries' which were tenable either in the CSIR's national research institutes or overseas had been introduced in 1952 with the intention of stimulating research considered to be of national importance and which, for one reason or another, was being neglected by South African universities. Both of these schemes fell away with the establishment of the research units. Four of the holders of senior research fellowships became heads of such units. They were Dr J L B Smith (Ichthyology), Dr Charles Koch (Desert Ecology), Prof. E M van Zinderen-Bakker (Palynology) and Prof. L H Ahrens (Geochemistry).

*University research
units*

By 1968, the following research units were being supported (as in the case of medical research, these units were built up around established research workers with an outstanding record of achievement):

Chromatography Research Unit, University of Pretoria (director: Professor V Pretorius), Cosmic Rays Research Unit, Potchefstroom University (director: Prof. P H Stoker), Geochemistry Research Unit, University of Cape Town (director: Prof. L H Ahrens), Marine Research Unit, Oceanographic Research Institute, Durban (director: Dr A Heydorn), Natural Products Research Unit, University of Cape Town (director: Prof. F L Warren), Oceanographic Research Unit, University of Cape Town (director: Prof. J K Mallory), Palynology Research Unit, University of the Orange Free State



The Desert Ecology Research Unit was housed in the Namib Desert Research Station on the banks of the Kuiseb River about 100 km from Walvis Bay

(director: Prof. E M van Zinderen Bakker), Solid State Physics Research Unit, University of the Witwatersrand (director: Prof. F R N Nabarro), Desert Ecological Research Unit, Namib Desert Research Station, Gobabeb (director: Dr C Koch).

Special bursaries

In 1971 additional funds made possible the introduction of a scheme for the award of a limited number of special merit bursaries for full-time post-doctoral studies, tenable at South African universities. Another scheme, fellowships for visiting scientists, enabled active research units and groups at South African universities to invite recognized scientists from abroad to work for periods of six months to a year at South African universities.

The active development of university research by the CSIR can, in large measure, be attributed to the first president, Dr Schonland, who initiated it, Dr W S Rapson, vice-president from 1958 to 1962, Dr S M Naudé, president, who took over personal responsibility until 1967, and Dr C v d M Brink who then assumed responsibility for university research on his appointment as a vice-president.

When Brink became president in 1971, he continued to be involved in devising new schemes for improving support for university research, although in 1974 he delegated the responsibility to Dr A P Burger, followed by Dr D M Joubert in 1976 and Dr C F Garbers in 1979. When Dr Garbers became president, Dr R R Arndt took over this task in 1981.

Grant support for wide fields of research

On the basis of the philosophy and practice which has been described, the funds allocated by the CSIR for the support of independent academic research at universities and museums through annual grants awarded on the basis of applications received from individual researchers, institutes and groups, amounted to R3 200 000 in 1980 and R10 000 000 in 1984–85. The vast field covered by this research was reflected in the names of the various units, groups and institutes receiving on-going support at that time. Two main categories could be identified:

1. Those receiving financial support from the CSIR and reporting back to the CSIR, and
2. Those financed by the universities concerned and reporting to councils appointed by them while receiving block grants from the CSIR. (These were in addition to some 1 500 individual grants.)

The organizations in the first group were the Geochemistry Research Unit, the Chromatin Research Unit and the Carbohydrate Chemistry Research Unit at the University of Cape Town; the Polyene Chemistry Research Unit at the University of Stellenbosch; the Flavanoid Chemistry Research Unit at the University of the Orange Free State; the Uranium Chemistry Research Unit at the University of Port Elizabeth; the Cosmic Ray Research Unit at Potchefstroom University; the Research Group on Solid State Electronics and the Magnetism and Semiconductor Physics Research Unit at the Rand Afrikaans University; the Desert Ecological Research Unit attached to the Transvaal Museum and situated at the Namib Research Institute in South West Africa; and the Photosynthetic Nitrogen Metabolism Research Unit attached to the University of the Witwatersrand.

The second group included the Bernard Price Institute for Palaeontological Research, the Hydrological Research Unit, the Solid State Physics Research Unit and the Institute for Nuclear Research at the University of the Witwatersrand; the Institute for Chromatography, the Institute for Microstructures, the Institute for Geological Research on the Bushveld Complex, and the Mammal Research Institute at the University of Pretoria; the Institute for Groundwater Studies and the Institute for Environmental Sciences at the University of the Orange Free State; the Institute for Freshwater Studies, the Tick Research Unit, and the J L B Smith Institute for Ichthyology at Rhodes University; the Percy Fitzpatrick Institute of African Ornithology and the Precambrian Research Unit at the University of Cape Town; the Southern Universities Nuclear Institute at Faure and the Group for Cenozoic and Sedimentological Research in the Southern Cape at the South African Museum in Cape Town.

The CSIR's various schemes for the support of university research grants were administered by a Research Grants Division under Mr M F Baxter until 1970, and from then on under Mr W J Weideman. Although reporting directly to the CSIR executive on all matters concerning grants, the division was attached to the CSIR's Administrative Services Department, except for a period of some 10 years in the 1960s and early 1970s, when it fell under the Information and Research Services and was called the University Research Division.

Changing circumstances in the 1970s, brought about by developments in science and technology and their effect on the global economic outlook coupled with rapid social changes in South Africa itself, required a reassessment of established procedures. In 1982, Professor J S de Wet, former dean of the Faculty of Science at the University of Cape Town, was appointed by the CSIR to investigate its support for research at universities, museums and technikons. This investigation was carried out in consultation with the Department of National Education, the University Advisory Council, the Committee of University Principals, the Chairman of the Scientific Advisory Council and the research workers at the institutions concerned. Many new proposals were put forward but all of them were based on retention of the established policy that the main criteria for support should be the calibre of the research worker, as reflected in the ability to produce good research results. In April 1984 it was announced that, to give effect to these proposals, two of the groups within the CSIR which were concerned with the support of research and development, known as the Research Grants Division and the Co-operative Scientific Programmes, were to be amalgamated to form a new organizational entity known as the CSIR Foundation for Research Development. This foundation would function under the direction of Dr R R Arndt, a member of the CSIR executive.

The main purpose of the funds administered by the Research Grants Division (amounting to R10,5 million in 1984) was to support self-initiated research and to build up centres of excellence around gifted individuals. In the Co-operative Scientific Programmes, on the other hand, these centres of excellence were offered the opportunity of contributing to the solution of complex national and international problems in co-operation with other bodies on a multidisciplinary, multi-institutional basis. In this context, the



Mr M F Baxter
Head of the Research Grants
Division until 1970



Mr W J Weideman
Head of the Research Grants
Division from 1970 on

*Foundation for
Research Development*

criteria for the acceptance of research proposals were the merit of the research workers as adjudged by an elaborate system of peer review, and in addition the extent to which the proposed research projects could help to fill important gaps in the national research effort. In effect these programmes were mission orientated but participation was voluntary and based on merit. The budget for the Co-operative Scientific Programmes amounted to R15 million in 1984.

Medical research

When the acting Prime Minister, J H Hofmeyr, introduced the Research Council Bill which provided for the establishment of the CSIR, he told Parliament that it was the intention that medical research would be included within the scope of the proposed research organization. He added, however, that it might eventually become the responsibility of a separate body. The principle that medical research would fall within the ambit of the CSIR was accepted by both sides of the House and confirmed in a letter from the Office of the Prime Minister in which the CSIR was given the specific directive to explore and develop the whole field of medical research in South Africa.

In the publication *Objects and Policy of the CSIR* (December 1945) (see p. 13) it was stated that the CSIR intended to explore vigorously the requirements of biological research basic to the whole field of medicine. As plans would take some time to formulate, the first step would be to support 'project researches in various universities, with a limited term of life, in order to see how they developed.' One such project in the field of nutritional research had already been approved by the CSIR Council.

Committee for Medical Research

To give effect to this mandate, the Council set up a Committee for Medical Research to review medical research needs and to submit recommendations for appropriate action. The members of this committee were nominated by the main medical interests in the country and met for the first time on 15 February 1946 under the chairmanship of Dr Schonland and with Dr P J du Toit as vice-chairman. At this meeting the committee accepted that medical research should be entrusted to the CSIR and agreed that there was no need for a separate medical research organization. This reflected the general view that the establishment of the CSIR heralded a new deal as regards state funding of research and development.

At that time medical research was centred mainly in the faculties of medicine at the Universities of Cape Town, the Witwatersrand and Pretoria, a veterinary faculty at the University of Pretoria, a faculty of dentistry at the University of the Witwatersrand and the South African Institute for Medical Research in Johannesburg. Later, faculties of medicine were established at the University of Natal in 1951, and the University of Stellenbosch in 1955, and a faculty of dentistry at the University of Pretoria in 1951. The limiting factors in their research activities were the shortage of suitable research staff and funds for following through research projects in depth.

At the second meeting of the Medical Research Committee, held in April 1946, it was agreed that clinical research in addition to laboratory research should be included in the scope of the CSIR. At the same meeting, the president of the CSIR indicated that the budget for medical research was relatively large and expected to grow rapidly. Provision might therefore have to be made for a medically qualified person to be appointed to a permanent post on the establishment of the CSIR with the responsibility for all aspects of medical research funded by the CSIR. As the incumbent of such a post would have to maintain personal contact with leading research workers overseas, only someone of high standing in the medical research field could be considered.

In 1947 the Committee for Medical Research was reconstituted. The members who had previously been nominated by various medical interests and organizations were replaced by members appointed on the grounds of their personal research standing. The new committee eventually became known as the Committee for Research in the Medical Sciences (CRMS). Professor S F Oosthuizen, professor of radiology at the University of Pretoria, was appointed chairman. This marked the beginning of the key role which he was to play in the activities of the committee and in the development of medical research under the auspices of the CSIR. In 1948, the CSIR Council decided on the basis of a memorandum from Professor Oosthuizen and a recommendation of the CRMS, to establish research units under leading research workers to ensure continuity of research. The significance of this decision by the Council was underlined by Schonland in the following terms:

'For medical research South Africa presents a unique field in the study and remedy of the diseases and the conditions which hamper its development, in particular malnutrition, amoebic dysentery, tuberculosis and, to a lesser extent, malaria and bilharzia. There is room also for considerable research in social and preventive medicine.

'Although a great deal has already been done to attack these problems practically, not nearly enough basic scientific research has been carried out and plans have now been formulated for the establishment at our universities of research teams on the lines successfully developed by the Medical Research Council of Great Britain.

'The field of medical research is one in which South Africa may perhaps return to the rest of the world some of the benefits which she has received from the development of scientific research in overseas countries. Her contribution is most likely to lie in the intensive study of problems peculiar to the African continent south of the Sahara, problems arising from the special nature of the geography, climate and peoples of Africa and which can only be solved effectively by extensive research in Africa.'*

In 1949 it was decided that the appointment to the CSIR staff of someone highly qualified and experienced in medical research was essential. As no such person was available, however, Professor Oosthuizen offered to serve

*Committee for
Research in the
Medical Sciences
(CRMS)*



Professor S F Oosthuizen
Member of the CSIR Council in 1946 and from 1962 until 1970. He also served as the CSIR's adviser on medical research and as chairman and honorary secretary of the CSIR's Committee for Research in the Medical Sciences

* Address to the Royal Society of Arts, London, 1948.



Professor T B Davie

as honorary secretary for medical research in addition to being chairman of the research committee. The following year Oosthuizen, for health reasons, resigned as chairman of the CRMS but agreed to continue to serve as honorary secretary. Professor T B Davie, principal and vice-chancellor of the University of Cape Town and a member of the CSIR Council, was appointed chairman in his place. On the death of Professor Davie in 1956, Professor Oosthuizen was once again appointed chairman and an executive committee of the CRMS was formed, consisting of Professor Oosthuizen, Professor J Barnetson and Professor H W Snyman, all of the University of Pretoria.

On a recommendation of the medical research committee, the CSIR invited Sir Edward Mellanby, secretary of the Medical Research Council of Great Britain, to South Africa to advise the Council on medical research in general and nutritional research in particular. As the British Medical Research Council (established in 1920) had introduced and successfully developed the whole concept of medical research units, his visit was of special relevance at the time. For continuing contact with advances in medical science in Western Europe and North America, the CSIR appointed as honorary medical liaison officers Professor G M Bull of Queen's University, Belfast, and Professor R M Kark of the University of Chicago. Working through the CSIR's scientific liaison offices in London and Washington, these two South African medical scientists provided a valuable link with research organizations and individuals overseas.

In the first year of operation the CSIR budget allocation for medical research amounted to £29 400. This made provision for some 25 bursaries, 10 research assistants, six research fellowships, three senior research fellowships, 12 technical assistants, major equipment and general expenses. The greater part of the budget gradually came to be allocated to the medical research units which, after 1948, were developed under leading research workers with annual grants guaranteed for periods of 3-4 years.

*Medical research
units*

The first units to be established were the Amoebiasis Research Unit, University of Natal, Durban (Head: Dr R Elsdon-Dew), Applied Physiology Unit, S A Institute for Medical Research, Johannesburg (Head: Dr C H Wyndham), Bilharzia Natural History Unit, S A Institute for Medical Research, Johannesburg (Head: Dr B de Meillon), Cardio-Pulmonary Research Unit, University of the Witwatersrand, Johannesburg (Head: Professor G A Elliot), Nutrition Research Unit, University of the Witwatersrand, Johannesburg (Head: Professor J Gillman), Social Medicine Research Unit, University of Cape Town (Head: Prof. J F Brock), Social Medicine Research Unit, Department of Health, Durban (Head: Dr S L Kark), Tuberculosis Research Unit, Department of Health, Durban (Head: Dr B A Dormer), Virus Research Unit, University of Cape Town (Head: Dr M van den Ende).

According to the CSIR's Fifth Annual Report (1950), about £52 500 was allocated for medical and dental research for the financial year 1950-51, of which some £10 000 was for *ad hoc* awards for medical research at universities, £7 500 for the South African Institute for Medical Research and £35 000 for medical research units.

In due course more units were established, while others were terminated on the recommendation of expert committees. For example, in 1951-52 the

responsibility for the Applied Physiology Research Unit was transferred to the Chamber of Mines, with the implication that this unit would be permanent and extended in scope. The CSIR retained two representatives on the controlling committee and the unit eventually developed into the Human Sciences Laboratory of the Chamber of Mines.

Long-term support for major on-going research projects was guaranteed on the same basis as for the research units. In certain fields in which more than one outstanding research worker was identified, 'research groups' were established – wider in scope and of higher standing than the research units under a single leader.

Organizational procedures became more sophisticated. Originally, an 'advisory panel' was appointed for each unit. These were later replaced by 'committees of control' and yearly visits by specialist 'assessors'. Yearly meetings of the directors of research units provided a valued forum for discussion and interchange of ideas.

In 1957, a commission of enquiry was appointed by the Governor-General to review the co-ordination of medical research in South Africa. Membership of the commission was as follows: Dr P J du Toit (veterinarian; chairman), Mr J B de Villiers, MP, Professor M van den Ende (virologist), Dr T Alty (physicist), Dr W H Craib (physician), Dr B M Clark (Department of Health).

Commission of enquiry

In its submission to the commission, the Committee for Research in the Medical Sciences expressed its satisfaction with the existing dispensation under the CSIR, but it recommended that a full-time senior executive should be appointed to be responsible for medical research. It also recommended that there should be a separate budget for medical research, and that in this field the CSIR should be accountable to a committee of ministers of departments concerned with medical matters.

In its report the commission of enquiry recommended inter alia that:

- All medical research should be co-ordinated under one body.
- This body should be required to advise the Government on the funding of medical research.
- Such a body should be established within the framework of the CSIR and replace the existing CRMS.
- The CSIR should report to the Prime Minister.
- Veterinary research should be included with medical research.
- The CSIR should create a post for a vice-president for medical research.
- Medical research should be funded by the Department of Health through the CSIR.

In 1962 the CSIR created the post of a vice-president for medical research, but at that stage no suitable senior academic could be found to fill this full-time administrative post. In 1965, however, the CSIR Council was pleased to accept an offer from Dr W H Craib to serve as full-time but temporary

vice-president for medical research and also as joint adviser for medical research with Professor Oosthuizen, who would continue as chairman of the CRMS.

In the meantime, Professor H O Mönnig, scientific adviser to the Prime Minister and chairman of the recently created Scientific Advisory Council, had objected to the recommendation of the commission of enquiry that the Veterinary Research Institute at Onderstepoort should be included with medical research within the ambit of the CSIR. He proposed a reorganization of research in South Africa which provided for a separate council for biological research which would include medical, dental and veterinary research.

Medical Research Council

After considering Dr Mönnig's proposal, the CRMS reaffirmed its satisfaction with the way in which medical research was functioning under the CSIR, but nevertheless indicated that should a separate medical research council be established, it would offer its full co-operation. After six months in office as vice-president for medical research, Dr Craib submitted a memorandum to the committee in which he pointed out that there were no underlying reasons for dissatisfaction with the present arrangements for medical research and that the only consideration which could favour the establishment of a separate autonomous body for medical research would be the enhanced status which this would provide and the possibility of increased funding. These views notwithstanding, Professor Mönnig informed the CSIR in August 1966 that a Cabinet committee was considering proposals for the establishment of a separate medical research council under the Minister of Health. The intention was that the headquarters of the proposed council would be on the CSIR site but that it would not have laboratories or institutes of its own.

In July 1968 the CSIR was notified that a Draft Bill for the establishment of a medical research council would be submitted to Parliament early in 1969 and that it was proposed that the council should be set up in April 1969. Dr Craib had retired in 1967 and in March 1968 Professor Oosthuizen resigned as chairman of the CRMS to be succeeded by Professor A J Brink of the University of Stellenbosch. In October of that year Professor H W Snyman resigned as a member of the executive committee of the CRMS and on 26 May 1969 the CRMS was formally dissolved. On 1 July 1969 the Medical Research Council was established by Proclamation No. 2719 in the Government Gazette in terms of Act No. 19 of 1969.

To this new council the CSIR transferred the medical research groups and units which had been set up as centres of excellence in specific aspects of medical and dental research, as well as the nutritional diseases component of the National Nutrition Research Institute (see p. 209).

Range and scope of medical research under the CSIR

The following schedule reflects the range and scope of research in the medical sciences which had been initiated and developed under the auspices of the CSIR during the previous 20 years.

By 1966-67, there were the following units/groups operating within this framework, for which the total budget provision was R385 656: Amoebiasis, Arthropod-borne Viruses, Bilharzia, Cardio-Pulmonary, Cardiovascular

Pulmonary, Clinical Nutrition, Degenerative Diseases, Dental, Endocrine, Heart, Human Biochemistry, Iodine Metabolism, Iron and Red Cell, Nutrition and Dental Health, Nutrition and Metabolism, Orthopaedic Development, Photobiology, Protein Research, Kidney Metabolism, Tissue Damage and Cell Metabolism, Tuberculosis, Virus, Bacterial Genetics and Nutritional Anaemia.

International co-operation

Traditionally, co-operation in science has always been between individual scientists, rather than between organizations and nations. Scientific societies evolved to facilitate personal contact between scientists, and the journals published by these societies gradually supplanted the voluminous personal correspondence between individuals. However, with the burgeoning of research activity and the consequent proliferation of these publications and increasing publication delays, personal contact between research workers became more important than ever before.

At the international level, scientific societies formed informal international associations for the different disciplines as a means of meeting the need for personal contact across political boundaries. After the First World War these informal associations became non-governmental international scientific organizations known as International Scientific Unions. In turn these Unions formed a joint body known as the International Council of Scientific Unions (ICSU).

In the period following the Second World War, science increasingly became the concern of governments. As a consequence, applied science and technology and the sciences on which they were based were drawn into national and international politics. Technological achievement became a critical factor in national development, and technical co-operation between governments played an increasingly important role in international diplomacy.

The CSIR thus found itself called upon to provide a channel through which scientists could play an effective role in advising the Government on scientific matters affecting its relations with other governments. At the same time it had a mandatory commitment to promote person-to-person contact between South African scientists and their counterparts in other countries. New thinking was required in developing the right approach to handling this dual responsibility.

South African scientific liaison offices overseas

One of the first steps taken by the CSIR towards the discharge of this responsibility was to take over the scientific missions in London and Washington which had been set up during the Second World War largely to serve the Director-General of War Supplies. The mission in Washington had been established by the Department of Commerce and Industry, while the London Mission operated under the military adviser in South Africa House.

*Science and
government*



Mr E Boden

In August 1945 arrangements were made with the Department of Defence for Major E Boden of the Special Signals Service to be seconded to the CSIR to set up the CSIR's first scientific liaison office in London pending his transfer to the CSIR staff on 1 January 1946. This office set the pattern on which the other liaison offices to be established overseas by the CSIR were modelled. Also in January 1946 Dr E P Phillips, retired Director of the Division of Botany, Department of Agriculture, was appointed temporary head of the scientific liaison office in Washington. However, for some years the Department of Commerce and Industry continued to have a representative in Washington attached to the CSIR office. In 1948 Mr D R Masson, who had held the post of assistant liaison officer in London from May 1946, was appointed head of the Washington office. These posts were usually held for periods of four to five years at a time.

Initially these two offices were much concerned with maintaining the informal flow of information which had developed during the war years, and with providing back-up and assistance to the newly established national research institutes of the CSIR in the procurement of equipment and documentation as well as in making arrangements for the training of new members of staff.

The British Commonwealth Scientific Conference held in London in 1946 recommended that the scientific liaison offices of all Commonwealth countries in London and Washington should be closely associated. This concept was accepted by the governments concerned, resulting in the establishment of what came to be known as the British Commonwealth Scientific Offices (BCSOs). Not only did the arrangement have logistic advantages; it also facilitated the exchange of information and the pooling of knowledge. When South Africa became a republic and left the Commonwealth in 1961, the CSIR's overseas offices ceased to be members of the BCSOs, but the informal contacts remained and were, in fact, extended by the formation of informal 'Science Attachés' Clubs' that met for lunch once a month.

The CSIR found its overseas offices so useful that in 1957 it set up a third office in Cologne, West Germany, temporarily under Dr J P van Zyl, former director of the Division of Chemical Services, Department of Agriculture, and then under Dr P le R Malherbe, formerly of the CSIR's National Chemical Research Laboratory. Subsequently a fourth office was established in Paris in 1968 under Mr O A van der Westhuysen of the International Relations Division of the CSIR's Information and Research Services.

Following the pattern set by these offices but for rather a different purpose, a scientific liaison office attached to the office of the South African Consulate-General in Teheran, Iran, was maintained by the CSIR from 1975 to 1978 under Mr G A Harvey (see p. 58). Mr N C Hauffe took over the office in November 1978 until the service was terminated in 1979.

Scientific representation in North America was strengthened when, in 1981, a new office for science and technology was attached to the South African Consulate-General in Los Angeles. Under Mr N C Hauffe, this office was responsible for maintaining contact with organizations and individuals in the western region of the United States and Canada. From 1984 until its

termination due to financial considerations at the end of 1985, Mr C G Hide, head of the Washington Office, was also responsible for the Los Angeles Office.

The general base-load functions of these offices became focused on document procurement and technical enquiries; arrangements for scientific and technical visitors to and from South Africa; recruitment of staff for the CSIR, universities and other bodies; representational activities; the supply of information on scientific and technological development for the CSIR and other research organizations in South Africa; and provision of advice on scientific and technical matters to the diplomatic missions to which they were attached. In this context, these offices were formally assigned responsibility for other countries as well. In 1985 the assignments were as follows:

London – United Kingdom, Scandinavian countries and the Netherlands.

Cologne (later Bonn) – West Germany, Austria, Switzerland, Italy.

Paris – France, Belgium, Spain, Portugal.

Washington and Los Angeles – USA, Canada and Latin America.

The effective performance of these functions required that the heads of these offices should at all times be conversant with current trends in science policies and technological development strategies not only in South Africa but also in the countries to which they were accredited. This implied personal contacts with leading personalities in relevant government agencies, research organizations, and university and industrial research centres. To facilitate contacts with official bodies and to serve as scientific and technological advisers to the heads of diplomatic missions, the heads of the offices were accorded diplomatic status – initially as science attachés and subsequently as counsellors: science and technology. In this capacity they were often involved in intricate negotiations concerning bilateral arrangements, membership of and participation in the activities of international bodies, such as Antarctic, space and oceanographic research.

These personal contacts also played an important role in advising South African scientists in planning overseas study tours and arranging interviews with overseas scientists with corresponding interests. Itineraries, travel arrangements and accommodation had to be arranged to fit in with these appointments. Conversely, these offices, in collaboration with the visitors' office of the CSIR in Pretoria, assisted foreign scientists who were planning to visit South Africa. In this way they played a significant part in promoting friendly relationships and the all-important person-to-person communications between scientists of many lands.

From the outset the facilities of these offices were available not for the exclusive benefit of the CSIR but to all other research organizations, universities, government departments and private sector undertakings in South Africa. As they became better known, increasing use was made of these services, which have at all times been highly regarded not only by South Africans but also in the many countries in which they were active.

Responsibilities of heads of offices



Mr C G Hide

HEADS OF CSIR OFFICES OVERSEAS

London

E Boden	1945–1950, 1956–1960
J P de Wit	1950–1954
A M Schady	1954–1956
J A King	1960–1965
C G Hide	1965–1970, 1975–1978
H J van der Merwe	1970–1975
J Morris	1978–1984
N C Hauffe	1984–

Washington

E P Phillips	1946–1948
D R Masson	1948–1953, 1958–1964
R G Shuttleworth	1953–1958, 1964–1978
C G Hide	1978–

Bonn (initially Cologne)

J P van Zyl	1957–1959
P le R Malherbe	1959–1963, 1965–1971
C G Hide	1963–1965,
W T de Kock	1971–1974
D H R Hellwig	1974–1980
L R P Butler	1980–1984
W J van Biljon	1984–

Paris

O A van der Westhuysen	1968–1973
P J van der Westhuizen	1973–1979, 1985–
J A Brink	1979–1985

Teheran

G A Harvey	1975–1978
N C Hauffe	1979 (6 months)

Los Angeles

N C Hauffe	1981–1984
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Bilateral co-operation with other developing countries

Iran

Following a visit to the CSIR by a group of Iranian parliamentarians who were visiting South Africa as guests of the Government, the leader of the group, Sharif Imami, president of the Senate in Iran, invited the president of the CSIR, Dr C van der Merwe Brink, to visit Iran. Sharif Imami, an engineer, was impressed by the organization of the CSIR to meet the research needs of a country with an economy comparable with his own, both being

characterized by an intrusion of First World high technology into a largely Third World situation. The outcome of Dr Brink's visit to Iran was a decision to set up a CSIR scientific liaison office in Teheran to exchange information and experience on the organization of research and development at the national level, and also to promote contact between research workers in South Africa and Iran.

The office was established in 1975 under Mr G A Harvey, an electrical engineer who had considerable experience in industry and international science and technology and was a former member of the Prime Minister's Scientific Advisory Council. As in the case of the other overseas offices it was attached to the South African diplomatic mission. However, unlike the other offices in leading First World countries where the information flow was essentially towards South Africa, the purpose of this office was to promote a two-way flow of information between two countries at an intermediate stage of technological development.

Contacts between leading Iranian universities, such as those of Teheran, Aryamehr, Shiraz and Isfahan, were built up with the Universities of Cape Town, Pretoria and the Witwatersrand with a view to staff and student interchange based on selected research programmes. However, the most significant input to the Iranian scientific scene came from various research institutes of the CSIR covering such aspects as water resources management (including a successful symposium held in Iran by the National Institute for Water Research), low-cost housing (guidelines provided by the National Building Research Institute) and fermentation technology (National Food Research Institute). An unexpected field of co-operation was optical astronomy between Shiraz University and the South African Astronomical Observatory, infra-red spectroscopy being the common interest.

Outside the immediate sphere of involvement with the CSIR, arrangements were made for a medical team from the Iranian Ministry of Roads and Transportation to examine medical facilities provided at remote construction sites in South Africa, such as at the P K le Roux Dam.

Effective liaison was maintained with representatives in Iran of the South African Department of Mines, the Industrial Development Corporation and with the external office of the South African Bureau of Standards in Geneva. The last-mentioned became necessary as tenders received from South Africa had to have a standard mark, recognized in Iran, covering the products involved.

Because of the importance attached to agriculture, the South African Minister of Agriculture was invited to Iran to review its five-year agricultural development plan. Visits to agricultural projects in various parts of the country, such as the rice paddies of the Caspian Sea area, the bread basket of Iran, culminated in an audience with the Shah.

At the request of Sharif Imami, Mr Harvey submitted a report embodying recommendations for the future development and co-ordination of scientific and technological research in Iran, based on the CSIR model. Unfortunately, as a result of political changes, the rule of the Shah came to an end and all official contact with Iran in the scientific field was terminated in 1979.

Contacts built up

Israel

The bilateral scientific exchange agreement which the CSIR entered into with the National Council for Research and Development of Israel in 1976 functioned successfully from the start. It provided, among other things, for the exchange of scientists to the extent of 12 man-months of research a year in various fields of science and technology.

During the first seven years, an average of five Israeli and five South African scientists were accepted for the exchange each year. The agreement provided for air fares to be paid by the sender country and subsistence by the host country. It also provided for an annual symposium to be held alternately in Israel and South Africa on a topic of mutual interest. The first symposium within this framework, on the recycling of waste water, was held in Israel in 1976. Subsequent symposia dealt with the following:

- Performance of materials in aggressive climates (Haifa, July 1977).
- Physics (Pretoria, July 1978).
- Alternative energy sources (Jerusalem, February 1980).
- Operations research (Pretoria, February 1981).
- Aquaculture (Herzlia, Israel, February 1982).
- Recent developments in metallurgy (Pretoria, November 1982).
- Catalysis (Jerusalem, November 1983).
- Coal technology (Israel, May 1984).
- Stereochemistry (Pretoria, March 1985).

As a result of these activities, close contacts developed between scientists in the two countries who had research interests in common. This led to an extension of the original agreement in order to accommodate collaborative research projects, the first two of which were initiated in 1983. In addition, the CSIR set aside a small fund for *ad hoc* visits of scientists in both directions.

Republic of China (Taiwan)

A similar exchange agreement was entered into with the National Science Council of the Republic of China (Taiwan) in 1980. However, owing to lack of mutual contact between scientists in the two countries, only seven South African exchange scientists and three Chinese scientists took advantage of the agreement during the first four years. Then, as a result of visits to all the South African universities and most universities in Taiwan by a senior member of the CSIR's International Relations Division, interest was stimulated and 19 requests from South African scientists and eight from Chinese scientists were received in 1984–85. In addition, in 1983 a joint workshop on metal alloys and ceramics was held in Taiwan, while in 1984 a joint workshop on semiconductor materials was held in South Africa. A delegation of South African scientists also visited research and commercial institutions in Taiwan engaged in research and development on freshwater and marine aquaculture.

South West Africa/Namibia

Scientific contacts in southern Africa were strengthened when a liaison office was opened in Windhoek in 1980 under Dr D H R Hellwig, former head of the scientific liaison office in Bonn, West Germany, and before that of the regional laboratory of the CSIR's National Institute for Water Research in Windhoek. This office was established at the request of the Administrator-General of South West Africa/Namibia to promote general co-operation in science and technology.

Apart from providing a general liaison function, this office was responsible for the compilation of a register of research projects, for an analysis of annual research expenditures and for arranging a techno-economic review as an aid to the identification of priorities in the planning of long-term research and development for the territory.

From the outset this was regarded as a temporary assignment until such time as the SWA Administration could make its own arrangements for the performance of these functions, and in 1983 the direct involvement of the CSIR was discontinued.

The Commonwealth connection

Activities in the field of intergovernmental co-operation in science were initially dominated by the Commonwealth connection. A British Commonwealth scientific conference held in London in June 1946 was attended by a strong South African delegation led by Dr Schonland. Some of the recommendations of this conference were:

- to call a Commonwealth conference on scientific publication;
- to invite Dominion governments to house all the Commonwealth scientific liaison offices in one building with a view to facilitating rapid liaison and achieving economies through the provision of common services;
- to suggest the establishment of an all-African scientific research council; and
- to encourage more freedom of movement of scientific workers within the Commonwealth.

The South African government accepted these recommendations and proceeded to arrange a conference for 1948 to discuss development of scientific research in Africa south of the Sahara.

Among other developments was the formation of a British Commonwealth Scientific Committee. The members of this committee were the heads of the national research councils (i.e. bodies equivalent to the CSIR) in the self-governing Dominions, and they met every two years in a different country for discussions on issues related to research and development policy, organization and management at the national level.

Another effective co-operative organization was the Commonwealth Aeronautical Advisory Research Committee. Its main purpose was to facilitate the exchange of information on aeronautical research and experience in

African regional scientific conference

member countries. For this purpose the committee identified a number of fields of interest to aircraft designers and operators. Member countries were invited to nominate people to collect information on development in those fields in which they had a particular interest. They were known as 'co-ordinators', one of whom was designated 'chief co-ordinator' for the Commonwealth. A chief co-ordinator was responsible for collecting 'situation reports' from the co-ordinators in his field in the other countries and producing a consolidated report for distribution to all concerned. Periodically these co-ordinators met, each time in a different member country. In February 1961, for example, meetings of the co-ordinators in the fields of atmospheric turbulence affecting the operation of aircraft and aircraft noise (of which Dr E C Halliday of the CSIR's National Physical Research Laboratory was the chief co-ordinator) were arranged in Pretoria by the CSIR. Formal participation by the CSIR came to an end when South Africa left the Commonwealth.

Africa south of the Sahara

In pursuance of the recommendation of the British Commonwealth scientific conference held in London in 1946, the South African Government agreed to convene an African regional scientific conference in 1948. The responsibility for organizing the meeting was assigned to the CSIR in association with the Department of External Affairs and other government departments. The purpose of the conference was to discuss collaboration in long-term research on specialized problems in Africa south of the Sahara.

- For practical reasons the conference was eventually held in October 1949 at the University of the Witwatersrand in Johannesburg. This was probably the largest scientific international conference to be held in South Africa up to that time. It was attended by delegates from all the territories of Africa south of the Sahara and by representatives of all the 'metropolitan governments' of the colonial powers. There were some 75 delegates from France, Belgium, Portugal, the United Kingdom and the African territories. The South African delegation numbered 36.

The conference unanimously passed a resolution inviting the governments concerned to set up an African Scientific Council, with a permanent scientific secretariat in Africa, 'to unite in one advisory organization all the functions necessary to ensure that the available scientific resources are used to the best advantage in the development of the human and material resources of the continent.' (CSIR 4th Annual Report, 1949).

The congenial spirit of this conference and its success in formulating and accepting a number of resolutions aimed at more effective regional scientific collaboration in Africa south of the Sahara undoubtedly owed much to the skill and experience of the chairman, Dr P J du Toit, at that time deputy president of the CSIR. As director of the Veterinary Research Institute at Onderstepoort from 1927 to 1948 he was well-known throughout Africa.

Following this conference the metropolitan governments of the colonial powers moved swiftly to establish a Commission for Technical Co-opera-

tion in Africa (CCTA) - an inter-governmental organization. At the inaugural meeting of the commission in Paris in 1950, a proposal for the establishment of a Scientific Council for Africa South of the Sahara (CSA) received unanimous support.

A special meeting to work out the detailed organization of the CSA was held in South Africa House, London, under the chairmanship of Dr du Toit, South Africa acting as host country. It was decided that 'the council would consist of a chairman and 12 members, selected in such a manner that the major scientific disciplines would be represented as well as the main regions in Africa south of the Sahara and the national governments . . . responsible for the development of these regions.'

The council met for the first time in Nairobi in November 1950 under Dr du Toit's chairmanship and was attended by

Prof. J Millot	Madagascar
Dr F J Cambournac	Portugal
Sir Alexander Carr-Saunders	United Kingdom
Dr B A Keen	British East Africa
Dr A Mendes Corr�ea	Portugal
Prof. T Monod	French West Africa
Col. H W Mulligan	Nigeria
Dr B F J Schonland	South Africa
Mr N P Sellick	Southern Rhodesia
Dr Georges J Bone	Belgian Congo
Prof. Trochain	French Equatorial Africa.

Mr D B Sole of the South African Department of External Affairs, Mr E B Worthington of the East Africa High Commission and Mr E Boden of the Liaison Division of the CSIR served as the secretariat.

The inaugural meeting was chiefly concerned with problems of organization and method. Fifty-three resolutions on scientific collaboration in Africa, adopted at the African regional scientific conference in Johannesburg in October 1949, were sifted and priorities allocated to assist governmental and other authorities to carry them out. As a first priority the following proposals were examined in detail:

- Establishment of an Inter-African Regional Bureau of Geology.
- Achievement of cartographic uniformity in the maps of Africa, and preparation of special regional maps on geology, climatology, vegetation, vector-borne diseases, etc.
- Extension of co-ordinated development in hydrology and water conservation.
- Calling of a specialist meeting on housing and building research.
- Co-ordination of scientific library and bibliographical services.

As a first step arrangements were made for the appointment of honorary regional consultants and correspondents in Africa to represent the main scientific disciplines. To avoid overlap, cognisance was taken of the activi-

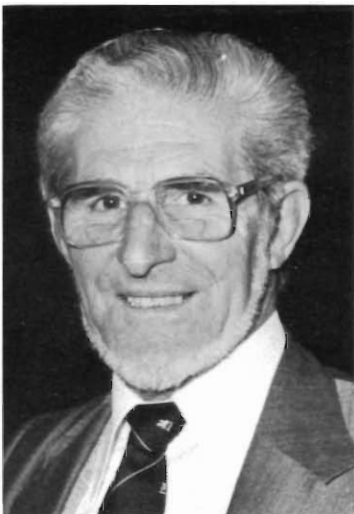
*Collaboration between
Africa's scientists*

ties of existing organizations dealing with specialized subjects such as trypanosomiasis, rinderpest and soil conservation.

The main objective was to facilitate a collaborative approach between scientists living and working in Africa with a view to more rapid progress in particular fields. The CSA eventually had 14 members and up to 20 alternate members – all eminent scientists drawn from the member governments and mostly working in Africa. They were appointed not as representatives of their governments but as authorities on scientific disciplines or groups of subjects. Two members (including the chairman) were South African, three (including the vice-chairman) were French, two Portuguese, two Belgian, three British and one a Rhodesian. Together they represented nearly all the major sciences and member countries. As members of the CSA their primary allegiance was to the advancement of science for the benefit of the region as a whole.

The council held annual meetings in different centres – in Nairobi, Dakar, Bukavu, Tananarive, Pretoria, Luanda, Yangambi, Kampala, Pointe Noire and Cape Town. At these meetings the whole field of science in Africa was reviewed and a few subjects of special importance were selected for detailed attention. The CSA thus effectively became the co-ordinating body between the different scientific disciplines.

From 1951 to 1954 the CSA and the Commission for Technical Co-operation in Africa (CCTA), as independent organizations, each had its own secretariat – the CSA in Nairobi under Dr E B Worthington*, formerly scientific secretary of the British East Africa High Commission, and the CCTA in London under Paul-Marc Henry of France. Whereas the functions of the CCTA, which had been established for political reasons, were mainly financial and administrative, the CSA, set up on the initiative of eminent scientists working in Africa, aimed at overcoming the isolation of scientists by bringing them together to pool their experience and knowledge gained through working in close contact with local problems. The functions of these two bodies were thus complementary and close co-operation between them was therefore essential. To facilitate this process the joint relationship between the two bodies was formalized by an agreement signed in London in 1954 and ratified by the governments concerned. The joint organization became known as the CCTA/CSA, the CCTA being the executive authority and the CSA its scientific advisory body. All secretarial functions were amalgamated under a common secretary-general, Mr Claude Cheysson of France, at the beginning of 1957. The main office continued to be in London until May 1959 when the secretary-general moved to Lagos. A smaller unit with a scientific secretary (CSA) continued to operate at Bukavu in the Belgian Congo. In 1959, Professor E T Verdier, of the University of Natal (the son of French Protestant missionaries in Basutoland and a graduate of Rhodes University, Grahamstown) was appointed scientific secretary of CSA.



Professor E T Verdier

* Worthington, E.B., *Science in the Development of Africa; A Review of the Contribution of Physical and Biological Knowledge South of the Sahara*. Commission for Technical Co-operation in Africa South of the Sahara and Scientific Council for Africa South of the Sahara, London, 1958.

Among the most important functions of CCTA/CSA was that of convening and organizing conferences, symposia and meetings on scientific and technical subjects. These enabled workers in specialized fields in Africa to meet and to review what had been done and to make suggestions for future developments. The larger of these meetings (three or four were held each year) were attended by about 100 delegates and dealt with a wide range of subjects such as soil, forestry, hydrology, education, urbanization and nutrition.

Thirty to 40 smaller meetings were also held each year. They were restricted not only in the number of participants but also in the scope of the subjects which usually dealt with some well defined technical problem such as absenteeism, radioisotopes, water contamination and treatment, climatology and roads, to mention only a few in which the contribution of South African workers was pre-eminent. All these meetings invariably finished their deliberations by drawing up a number of conclusions or recommendations for consideration by CCTA/CSA.

In addition, several inter-African information bureaux were set up, such as –

- The Inter-African Bureau for Epizootic Diseases (IBED),
- Bureau Permanent Interafricain pour la Tse-tse et la Trypanosomiase (BPITT) in Leopoldville,
- Inter-African Bureau for Animal Health (IBAH) in Muguga,
- Bureau Interafricain des Sols (BIS) in Paris,
- Inter-African Labour Institute (ILI) in Brazzaville, and
- Inter-African Phytosanitary Commission (IAPSC) in London.

Inter-African information bureaux

As these information bureaux with their permanent staff were costly undertakings, other more informal arrangements were tried. For example, for geology a full-time inter-African scientific correspondent, based in Pretoria, was appointed in 1954. He was Dr S H Haughton, retired director of the Geological Survey of South Africa. Dr Haughton was responsible for maintaining contact with geological surveys in the various territories working in close touch with the pre-existing Association of African Geological Surveys. For this purpose, Africa was divided into regions, namely West Central, South Central and East Central, each with its own regional committee for geology which held regular meetings. Similarly the problems of the conservation and use of soils were dealt with by four regional committees of which the Southern Africa Regional Commission for the Conservation and Utilization of the Soil (SARCCUS) was certainly the most active under its first secretary, Dr J C Ross, a former director of the Division of Soil Conservation of the South African Department of Agriculture. This committee covered a wide variety of subjects including nearly every branch of human, animal, plant and physical activity. It should be noted that the committee outlived its parent organization.

Two creations of CCTA/CSA of a different kind were the Inter-African Research Fund and Inter-African Foundation for the Exchange of Scientists and Technicians. The first project to be financed under the former was the

CSIR's involvement

Climatological Atlas of Africa, undertaken by Professor S P Jackson of the University of the Witwatersrand (published in 1961).

To illustrate the involvement of the CSIR's national research laboratories and institutes in research of peculiar interest to the development of Africa, two examples are given here.

Firstly, following a meeting held in Pretoria in 1955 the National Building Research Institute assisted the CCTA/CSA Inter-African Committee on Housing to promote co-operation and the exchange of information between member countries in Africa on research into building practices relating to housing. The secretariat for this committee, which was provided by the institute, was mainly occupied in assisting the CCTA/CSA general secretariat with preparations for four inter-African meetings and symposia dealing with building research, school buildings, and health aspects of housing. In addition, a directory of research organizations in Africa carrying out research or providing information on housing, was compiled and distributed; a report on soil and foundation problems experienced in Africa was prepared; and climatological data relevant to building design, as well as data on a suitable system for the costing of house construction and the provision of related services, were compiled. Information was collected from various parts of the world on the design of low-cost stoves operating on wood, coal, oil, gas or solar energy which might be suitable for low-cost housing in Africa.

Secondly, the National Institute for Personnel Research devised procedures for the selection and occupational classification of workers for the use of centres set up by mining and secondary industries and by governments. These procedures were instituted not only in South Africa but also in the Federation of Rhodesia and Nyasaland, East Africa and Ghana. For Basutoland (Lesotho) a pilot study was carried out on the selection of pupils for technical schooling. Tanganyika (Tanzania), Uganda, Southern Rhodesia (Zimbabwe) and Northern Rhodesia (Zambia) were interested in this problem and sent administrative staff to the Institute for orientation courses.

In September 1960, at a meeting of the CSA in Cape Town, Dr P J du Toit resigned as its president, a position he had held since its inception in 1950. For 10 years he had guided the activities of the CSA at numerous meetings held in east, west, central and southern Africa. At the same meeting Dr S Meiring Naudé, who had been a member since 1955, was elected vice-president.

There is no doubt that the CSA succeeded to a remarkable degree in achieving its objectives of regional collaboration through a system of meetings of specialists and inter-African correspondence for specialized subject fields. Unfortunately, for the sake of administrative convenience, the CSA had been linked to the CCTA, which was an intergovernmental organization established on the initiative of the metropolitan colonial powers. Thus, although the CSA, both in its ideals and methods of working, was non-governmental, it did not escape the taint of colonialism and was rejected by the new independent African states and was dismantled by 1965.

The International Council of Scientific Unions (ICSU)

From 1931 onwards South Africa was a member of the International Council of Scientific Unions (ICSU) (referred to on p. 55) and certain of its constituent international scientific unions. The main criterion for national membership of an international scientific union was that the national adhering body should be representative of the scientists in the country and form a representative national committee in the discipline concerned. The former National Research Council and Board of the Union Department of Education had been the national adhering body. However, on its establishment in 1945, the CSIR assumed this responsibility, which included payment of annual subscriptions to the ICSU and to the separate unions, on behalf of the local national committees. As the national adhering body, the CSIR through its Liaison Division (later the International Relations Division of the Information and Research Services) also provided secretarial services for the national committees, distributed information to members and arranged for the participation of South African scientists in the activities of the international unions.

This remained a low-key activity of the CSIR until the ICSU began planning for the International Geophysical Year (IGY, 1957–58), as a logical successor to the International Polar Years (1883–84 and 1933–34). A national committee to organize South Africa's participation in this international programme was set up by the CSIR under the chairmanship of Dr T E W Schumann, director of the Weather Bureau, who had been invited by the ICSU to serve on its special committee for the IGY.

Through this national committee a South African national programme for the IGY was planned, involving all government agencies, universities and other research institutions which could make an effective contribution to global observation programmes. These included fields such as meteorology and Antarctic research (participation in the Commonwealth trans-Antarctic Expedition under Sir Vivian Fuchs), geomagnetism, cosmic rays, ionospheric observations, tracking of 'artificial earth satellites' (proposed by the USA), physical oceanography, geodesy and geology. The budget for this programme amounted to some £150 000 and the Treasury approved allocation of the appropriate amounts to the Departments concerned. The CSIR's share came to a modest £11 000, most of which was transferred to universities for specific projects. The IGY proved to be a highly successful exercise in international collaboration in science, largely owing to the procedures evolved by the ICSU through which global programmes were planned by international panels of experts.

At the national level scientists concentrated their efforts on those aspects of the international programme to which they could make worthwhile contributions by virtue of geographical position, the availability of local resources such as manpower, facilities, expertise and funds. National funds were allocated primarily for the national effort while only modest contributions were made towards international expenses, such as those required for international meetings. This procedure provided a basis for effective international co-operation in research related to global phenomena and for the stimulation of research at the national and regional level.

International Geophysical Year

The success of the IGY greatly stimulated international interest in the possibility of other international programmes in related fields. The succeeding year saw an increasing involvement of South African scientists and scientific institutes in a series of international scientific programmes launched under the auspices of the ICSU. To handle this situation the CSIR established an Advisory Committee for International Co-operation in Science which met for the first time in July 1959. This committee, which was recognized as the South African National Committee of the ICSU, reviewed South African participation in the activities of the ICSU, its constituent unions and interdisciplinary scientific committees, as well as South African representation at meetings of these bodies.

Arising out of the International Geophysical Year (IGY) four committees were set up by the ICSU to carry forward work initiated during the IGY: the International Geophysics Committee (CIG), the Special Committee for Antarctic Research (SCAR), the Special Committee for Oceanographic Research (SCOR) and the Special Committee for Space Research (COSPAR).

Later these committees became permanent and were renamed scientific committees.

Antarctic research

Arising directly out of the multinational effort in Antarctica during the IGY, the 12 nations most directly concerned, including South Africa, signed an Antarctic Treaty in 1961 according to which all territorial claims to Antarctica were frozen and the signatory powers undertook to dedicate the region south of latitude 60°S to scientific research. The Department of Transport, which had been designated by the Government as the official agency for Antarctic matters, moved quickly to stage a scientific expedition to Antarctica. By agreement with the Norwegian Government, this expedition led by Mr J J le Grange of the Weather Bureau (who had been a member of the Commonwealth Trans-Antarctic Expedition under Sir Vivian Fuchs), occupied the Norwegian IGY base in Queen Maud Land in 1960.

The ICSU, through its Scientific Committee for Antarctic Research, continued to be responsible for planning and co-ordinating Antarctic research at the international level. The CSIR as the national adhering body set up the South African National Antarctic Research Committee under the chairmanship of Mr M P van Rooy, director of the Weather Bureau. The secretariat of this scientific committee was provided by the CSIR's International Relations Division. The committee had its first meeting in January 1961, and this collaborative arrangement continued to provide an effective medium for organizing the participation of South African scientists in Antarctic research. When Mr van Rooy retired from the Weather Bureau, Dr F J Hewitt, at that time vice-president of the CSIR, was appointed chairman of this committee which was renamed the South African Scientific Committee for Antarctic Research (SASCAR).

The CSIR's International Relations Division was responsible for the arrangements for the first symposium on Antarctic geology together with the 7th meeting of the Scientific Committee for Antarctic Research held in Cape Town in September 1963 under the auspices of the ICSU. Prominent scientists from overseas attended these highly successful meetings which

were preceded by visits to geological sites in the four provinces which featured striking similarities to Antarctic geology.

On the advice of the South African National Committee for Oceanographic Research (SANCOR) set up by the CSIR in 1960 (see also p. 74), the CSIR Council strongly recommended to the Government that a sum of R64 500 be made available to enable South African scientists to play an effective part in the International Indian Ocean Expedition (IIOE) 1962–63, organized under the auspices of the ICSU's Scientific Committee for Oceanographic Research (SCOR). The bulk of these funds went to universities and similar institutions for research into those aspects of the international programme which were of direct interest to South Africa and to the participating 16 nations.

Upper atmosphere physics featured prominently in the IGY programmes and stimulated interest in further international collaborative efforts. The successful launching of earth satellites, carrying sophisticated equipment with the capability of transmitting observational data back to earth, added a new dimension to research in the field of solar-terrestrial physics. To provide a forum for reviewing many and varied proposals for international collaborative programmes or projects the CSIR formed the South African National Committee for Geomagnetism, Aeronomy and Space Sciences (SANCGASS), the members of which were leaders of groups active in this field in South Africa. Because of its geographical situation, South Africa with its Antarctic base (Sanae) and weather stations in the sub-Antarctic islands of Marion and Gough, was particularly favourably placed for studies of the so-called 'South Atlantic magnetic anomaly' and associated phenomena. For example, programmes on the ionosphere, cosmic rays, various aspects of geomagnetism, aurora and 'airglow' were supported.

Participation in 'space research' centred largely in the CSIR's National Institute for Telecommunications Research which, during the IGY, operated a 'Minitrack' station for the radio tracking of satellites on behalf of the National Committee of the USA (see also pp. 181-185). A major co-ordinated effort in upper atmosphere physics was the South African national programme, part of the ICSU's International Quiet Sun Years (1964–65) programme. A highlight of this programme was four long-range research flights from Cape Town into the area of the South Atlantic magnetic anomaly. Subsequently, although South African scientists continued to play an active part in the activities of the ICSU unions concerned with upper atmosphere physics such as the International Union of Scientific Radio and the International Union of Geology and Geophysics, the main focus of interest was in the upper atmosphere physics programme of the Scientific Committee for Antarctic Research. In the 1970s and 1980s satellite remote sensing came increasingly to the fore and included atmospheric observations in preparation for the Global Atmospheric Research Programme (GARP), a joint venture of the ICSU and the World Meteorological Organization (WMO).

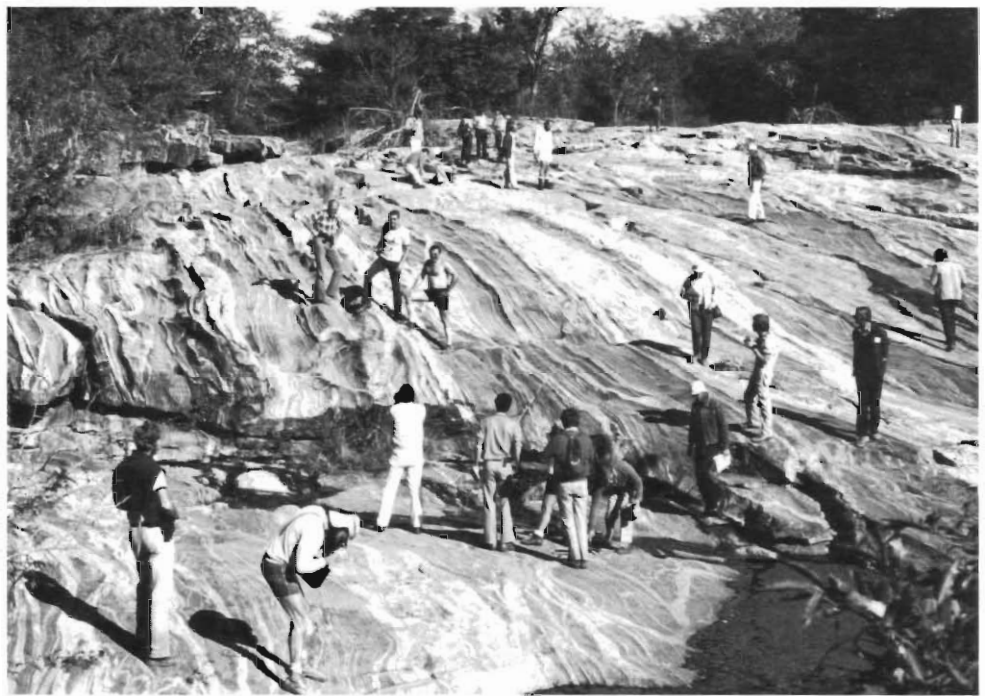
On the recommendation of the CSIR, the Government made available a sum of R136 000 for South Africa's participation in the international Upper Mantle Programme launched in 1965 under the auspices of the ICSU by the International Union of Geological Sciences (IUGS). On the advice of the

Oceanography

Upper atmosphere physics

Geological sciences

A group of geologists on one of the field excursions held in conjunction with the Second International Gondwana Symposium, 1970



South African national committee for the IUGS, these funds were allocated by the CSIR to universities and other organizations for geological research projects in southern Africa as part of the Upper Mantle Programme. This programme embraced a comprehensive study of the outer layer of the earth's crust (to a depth of 1 000 kilometres). Formal participation in this programme came to an end in 1968 and the results which were presented at a symposium organized by the CSIR, were published as a 'special publication' of the Geological Society of South Africa.

A notable event in 1970 was the second international symposium on Gondwana stratigraphy and palaeontology arranged by the CSIR under the aegis of the International Union of Geological Sciences. The first sessions were held in Cape Town and were followed by field excursions to the Karoo and parts of the Transvaal and Natal where visitors had the opportunity of seeing the rock types of the Karoo System and the fossils they contain. The symposium ended with sessions in Johannesburg. It was attended by 180 scientists of whom about a half came from other countries.

The International Geodynamics Programme (IGP), which was initiated in the early 1970s by ICSU's Inter-Union Commission on Geodynamics, was in many ways complementary to the Upper Mantle Programme and provided a framework for a continuing national programme in South Africa and paved the way for a National Geoscience Programme in the 1980s (see p. 76).

*Biological sciences
and the environment*

The concern of the international community over the rapid changes taking place in all environments throughout the world found expression in ICSU's five-year International Biological Programme (IBP) for the planning and co-ordination of which ICSU set up a Special Committee (SCIBP). Because of the variety of environments and ethnic groups in South Africa and its wealth of natural biological resources, this initiative found a ready response from the South African scientific community. Accordingly the CSIR formed a national committee for the IBP under the chairmanship of Professor C A du Toit, professor of zoology at the University of Stellenbosch and a member of the CSIR Council. The South African programme drawn up by the national committee and approved by the CSIR included the productivity of

terrestrial, freshwater and marine communities, conservation, use and management of biological resources, and human adaptability.

After an intensive period of planning the South African national programme as part of the international programme of the International Biological Programme, was carried out most effectively. This success set the scene for participation in a follow-up programme which was launched under the leadership of the ICSU's Scientific Committee on Problems of the Environment (SCOPE) and for the establishment of a continuing South African national programme of research in the environmental sciences.

In 1971, the CSIR arranged a meeting of the executive committee of the International Union for Biological Sciences in Cape Town. This meeting, which was the first of its kind to be held in South Africa, was attended by the Secretary-General of ICSU, Professor F A Stafleu.

Within the framework of the Information and Research Services of the CSIR, scientists on the staff of the International Relations Division under Mr E Boden and Mr C G Hide were responsible for professional and secretarial services required by the national committees of the International Scientific Unions as well as for the international programmes. As participation in international programmes was stepped up, a Science Co-operation Division was formed alongside the International Relations Division under Mr G H Oosthuizen, supported by Mr O A van der Westhuysen and Mr P J van der Westhuizen. These divisions were primarily concerned with organizing and co-ordinating the participation of South African research organizations and university research groups in national programmes (as part of ICSU's international programmes). The president of the CSIR, Dr S M Naudé, was closely associated with these activities and was chairman of several of the national committees.

They also collaborated in arranging South African representation at international meetings of the ICSU and its constituent unions and were closely involved in organizing international conferences and symposia in South Africa (in collaboration with the CSIR Symposium Secretariat) under the aegis of the ICSU. Between 1960 and 1985 the following meetings were held in South Africa under the auspices of the ICSU:

Date	Title	ICSU body
September 1963	Seventh meeting of the Scientific Committee for Antarctic Research	SCAR
July 1969	Chemical control of the human environment	IUPAC
July 1970	Second international symposium on Gondwana stratigraphy and palaeontology	IUGS
September/ October 1973	International conference on kimberlites	IUGS
November 1975	Meeting of executive committee, Scientific Committee for Oceanographic Research	SCOR
August 1976	International symposium on analytical chemistry in the exploration, mining and processing of materials	IUPAC
June 1977	International conference on advanced treatment and reclamation of wastewater	IAWPR

Date	Title	ICSU body
July 1977	4th meeting of the Subcommittee for Precambrian Stratigraphy	IUGS
August 1978	International conference on dynamical properties of heavy ions	IUPAP
August 1979	Biomass working party on bird ecology	SCAR/SCOR
July 1979	Reunite Gondwanaland	CMG of IUGS
September 1980	Symposium on automatic control in power generation, distribution and protection	IFAC
July 1981	Geocongress 1981	IUGS
April 1982	11th conference of the International Association on Water Pollution Research	IAWPR
July 1982	International symposium on toxins and lectins	IUBS
August 1982	13th international symposium on the chemistry of natural products	IUPAC
November 1982	International conference on recent developments in specialty steels and hard materials	IUPAP
December 1982	First African recombinant DNA training course	COGENE
January 1983	Sandy beaches as ecosystems – an international multidisciplinary symposium	SCOR
September 1983	Biomass executive meeting	SCAR
September 1983	Scientific Committee for Antarctic Research group of specialists on seals	SCAR/SCOR
September 1983	Fourth symposium on Antarctic biology	SCAR/SCOR/ IUBS
September 1983	SIBEX 1 (Indian Ocean Sector) planning meeting	SCAR/SCOR
September 1983	Biomass working party on bird ecology	SCAR/SCOR
December 1983	Late caenozoic palaeoclimates of the southern hemisphere	INQUA
July 1984	Perspectives in southern hemisphere limnology	SIL/IUBS
March 1985	Muscles and membranes	IUBS
April 1985	Biomass working party on bird ecology	SCAR/SCOR
April 1985	2nd international symposium on analytical chemistry in the exploration, mining and processing of materials	IUPAC
July 1985	6th international symposium on mycotoxins and phycotoxins	IUPAC
August 1985	Study group on recent climatic change	IGU
September 1985	Third international protea conference and first protea research symposium	IUBS
November 1985	Symposium on production of vegetables and fruits for processing in tropical and mild winter areas	IUBS

Under the auspices of the ICSU's Scientific Committee on Genetic Experimentation a training course in genetic experimentation techniques for participants from African countries was offered at the University of Cape Town from 22 November to 10 December 1982. The course was run by international experts from France and South Africa. It was attended by 20 selected participants, 14 from South Africa and six from other African countries.

Co-operative scientific programmes

The success of South African participation in the programmes of the International Council of Scientific Unions (ICSU) led Mr G H Oosthuizen, head of the Science Co-operation Division of the CSIR's Information and Research Services, to suggest the possibility of national co-operative scientific research programmes independent of the ICSU. He argued that such a programme already existed under the South African National Committee for Oceanographic Research (SANCOR) following the termination of the International Indian Ocean Expedition in 1965. Therefore, when the International Biological Programme ended in 1972, a decision was taken to set up a National Programme for Environmental Sciences as a continuing activity of the Science Co-operation Division. In subsequent years similar programmes evolved for the earth sciences and atmospheric and space sciences.

By 1975 these programmes had expanded to such an extent that a separate group, directly responsible to the president, Dr C v d M Brink, was formed within the CSIR. Known initially as the National Scientific Programmes Unit, under Dr R G Noble, it subsequently came to be known simply as the Co-operative Scientific Programmes (CSP).

The role of the co-operative programmes was to identify and define problems peculiar to South Africa which, because of their magnitude and complexity, required the co-ordinated effort of a number of different organizations in planned research programmes. They funded research projects from funds provided by the CSIR and increasingly by other agencies. The CSP closely involved potential users in all aspects of the programmes, and some of the organizations which needed the results of research for their management decisions entered into contracts with the CSP to act as their agent in setting up, managing and funding research within these programmes.

By 1978 about 800 individual researchers from some 80 South African research organizations were actively involved in co-operative scientific programmes related to such wide-ranging and complex areas as the earth sciences, Antarctic research, marine sciences, weather, climate and atmosphere, remote sensing, ecosystems, materials, microelectronics, biotechnology, aquaculture and energy. In addition, the CSP managed an annual summer school in theoretical physics from 1981.

In April 1984 the Co-operative Scientific Programmes and the Research Grants Division were combined to form the CSIR Foundation for Research

Development (FRD), thereby consolidating the scientific support services of the CSIR.

The following give some indication of the scope and nature of the CSP's national scientific programmes:

Marine sciences

Oceanography is essentially a multidisciplinary science in which many different bodies are involved. During the 1950s the leading protagonist in this field was Dr T B Davie, principal of the University of Cape Town and a member of the CSIR Council. At his instigation an inaugural meeting of all interested parties was held in Cape Town under the chairmanship of Dr S M Naudé, president of the CSIR, to set up a co-ordinating committee for oceanography. This led to the establishment by the CSIR in the early 1960s of the South African National Committee for Oceanographic Research (SANCOR) as the advisory body for co-operative programmes in the field of the marine sciences. It served as the national committee for the ICSU's International Indian Ocean Expedition (IIOE) 1964–65 and for the International Scientific Committee for Oceanic Research (SCOR). Following the success of the IIOE, the Government allocated R100 000 towards the establishment of a continuing national programme for oceanographic research, to be administered by the CSIR in consultation with SANCOR. The programme was concerned with promoting and reviewing research in the fields of marine biology, physical and chemical oceanography, and marine geology.

Because of the extent, complexity and multidisciplinary nature of the programme which developed during the 1970s, it was reorganized in the early 1980s into a series of multidisciplinary research programmes to address specific problem areas associated with the marine environment. Oil pollution, estuaries, the coastal zone, angling fish resources, marine pollution, deep ocean sedimentology and the fisheries of the west coast Benguela system became the target of intensive multidisciplinary research programmes aimed mainly at providing scientific information, both basic and applied, for coastal zone and resource management. For example, the preparation of detailed coastal oil pollution contingency plans were prepared from investigations undertaken with financial support from the Department of Transport. An example of more basic work was the unravelling of circulation patterns of the sea off the south western Cape which subsequently proved of immense value in understanding the recruitment of fish into the west coast system.

As a result of participation in international space research activities, South African scientists had acquired an understanding of the practical applications of space techniques. This enabled local research groups to take part in an investigation of the usefulness of satellite remote sensing techniques in oceanography. Consequently a programme proposed by South Africa was one of only two proposed from outside North America to be accepted for the Nimbus 7 satellite launched late in 1978. The highly successful South African programme succeeded in correlating satellite data with ocean productivity in the upwelling areas off the Cape coast and with sediment



The Antarctic supply/research ship *SA Agulhas* anchored off the rocky coast of Marion Island

concentrations off the east coast. The experiment was an excellent example of collaboration between the Sea Fisheries Research Institute, the University of Cape Town and the CSIR.

A co-operative research programme was launched in 1979 for the study of the Southern Ocean – the vast circumpolar expanse of water surrounding Antarctica. This programme was closely linked with international activities in the area and especially with the BIOMASS (biological investigation of marine Antarctic systems and stocks) programme of the Scientific Committee for Antarctic Research – an international project in the formulation of which South African scientists were closely involved. The new Antarctic supply/research vessel, the *SA Agulhas*, commissioned in 1978, gave South African marine scientists the opportunity to make a valuable contribution to expanding the existing information on the Southern Ocean, thus ensuring the rational exploitation and conservation of the resources of the area. In 1983 this programme of research was incorporated in the South African National Antarctic Research Programme described below.

Antarctic research

South Africa, as one of the original 12 signatory powers to the Antarctic Treaty of 1961 and a founder member of the ICSU's Scientific Committee for Antarctic Research (SCAR) founded in 1958, accepted an obligation to contribute effectively to Antarctic research. The arrangement which was arrived at in the early 1960s for this purpose was that the Department of Transport should be primarily responsible for administration, finance and logistics. This included transport of and equipment for expeditions, and the establishment and maintenance of the bases at Sanae, Queen Maud Land, Antarctica, and on the sub-Antarctic islands of Marion and Gough. The CSIR, on the other hand, accepted responsibility for directing and co-

ordinating the scientific programmes with the advice and assistance of a South African Scientific Committee for Antarctic Research (SASCAR), which also served as the national committee for SCAR.

Initially the South African National Antarctic Research Programme was mainly concerned with meteorology (Weather Bureau), geology (Geological Survey), geomagnetism and the aurora (Magnetic Observatory, Hermanus), cosmic rays (Potchefstroom University), ionosphere (Rhodes University and the National Institute for Telecommunications Research of the CSIR) and airglow (University of Stellenbosch). Later the scope of the Antarctic programme was gradually extended to include research not only in the earth and physical sciences but also in the biological sciences in Antarctica and on the sub-Antarctic islands, as well as the oceanography of the Southern Ocean. By 1985, 16 university departments, three museums, three government agencies and three CSIR institutes were participating in these programmes.

Geological sciences

During the 1970s the South African geologists who had participated in the international Upper Mantle Programme, continued to co-operate in a National Geodynamics Programme. The South African contributions to the Upper Mantle Programme in the 1960s were concentrated on a study of the composition of the mantle. This study was based primarily on evidence of inclusions found in kimberlites and on information from the greenstone belts, with Barberton as a model. The National Geodynamics Programme, which formed part of the International Geodynamics Programme started in 1970, was a logical successor to the Upper Mantle Programme. It concentrated on dynamic processes in the earth's crust and resulted in an improved understanding of the major southern African mobile belts and zones and their contacts with cratonic regions, as well as of the Karoo dolerites. In 1980, following two years of intensive consultation between geologists, geophysicists and other earth scientists, a further National Geoscience Programme for the 1980s was formulated. It was agreed that the theme of the programme would be 'The evolution of earth resource systems', having as its broad objective an improved understanding of the principles and processes by which elements concentrate in the earth's crust to form ore deposits. Although not directly concerned with mineral exploration, the results could be expected to contribute to the development of search strategies.

Space and atmospheric sciences

A National Programme for Remote Sensing was initiated in 1975 with research focusing on land cover (agricultural crops, forests and natural vegetation), the geosciences, oceanography, and data acquisition, processing and display. Imagery available from LANDSAT and SPOT satellites as well as aerial photography, was used for this purpose.

The National Programme for Weather, Climate and the Atmosphere which was started in 1981 grew out of the former Atmosphere Section of the National Programme for Environmental Sciences. The scope of this new programme included:

- *weather and climate* –
 - climate variability and change
 - synoptic and dynamic meteorology
 - ocean climatology
 - mesometeorology and climatology
 - agrometeorology and climatology
 - hydrometeorology and climatology
 - physics and climatology of hail and thunderstorms
 - solar terrestrial climate relationships
 - precipitation research
 - palaeoclimatology
- *atmospheric interaction* –
 - methodology of climate impact assessment
 - influence of climate on man and his environment
 - influence of man's activity on climate and his environment
- *data and information requirements.*

Environmental sciences

The National Programme for Environmental Sciences was set up in 1972 to stimulate and co-ordinate research on selected environmental problems of regional, national or global importance in natural or seminatural systems within the biosphere, as well as research on aquatic and terrestrial ecosystems and their soil and water substrata.

This programme was, in effect, a logical outcome of the successful national contribution to the International Biological Programme (IBP) of the International Council of Scientific Unions and provided inputs to the ICSU's Scientific Committee on Problems of the Environment. The programme involved government departments, provincial and local authorities, statutory bodies and other research institutions, and 14 universities. More than 100 scientists were directly involved in research projects in the following programmes:

- Inland water ecosystems, including mineralization, aquatic weeds, eutrophication, coastal lakes, manmade lakes, the Pongolo floodplain, cattle-biting flies and heavy metals.
- Terrestrial ecosystems, including savanna and fynbos ecosystems, the areas affected by the extraction of water from the Kuiseb River in South West Africa/Namibia, fire ecology, threatened biota, pesticides in the environment, invasive exotic plants, and vegetation changes.
- Marine pollution, with a national marine pollution survey and programmes on coastal currents, heavy metals and ecotoxicology.
- The atmosphere, with programmes on mesometeorology, urban heat islands, the atmospheric transport of pollutants, climate cycles, and the monitoring of atmospheric pollutants.
- Waste management, with programmes on urban and industrial waste.
- Human needs, resources and the environment, with programmes on quality of life.

Savanna Ecosystems Project

The National Programme for Environmental Sciences, well known for the Savanna Ecosystems Project conducted at Nylsvley Provincial Nature Reserve in the northern Transvaal, followed the pattern of the major IBP biome projects conducted in the 1970s in the USA. The project involved the collaborative effort of the Provincial Nature Conservation Division (which provided researchers and managed the nature reserve), the Department of Agriculture (which provided researchers and translated the findings into practical agriculture), as well as seven universities, the Transvaal Museum and the CSIR. From very small beginnings the Nylsvley project established South African savanna researchers in a position of world leadership in the field, and researchers from Nylsvley came to play leading roles in the Decade of the Tropic Programme of the International Union for Biological Sciences. Similar multidisciplinary ecological studies were instituted in the fynbos, Karoo, grassland and forest biomes of South Africa.

Problem-oriented studies involving interdisciplinary research into environmental impacts had an important bearing on decision taking in major development projects. For instance, the Pongolo floodplain project involved an integration of sophisticated studies of the aquatic and terrestrial ecosystems and the human population affected by the construction of the Pongolopoort Dam. It led to the development of a water management strategy to make the most of benefits and reduce risks from threatened biota, ecosystems and economic development. Other examples were the impact of the increased water extraction from the Kuiseb River basin in South West Africa/Namibia and the effects of pollution and nutrient enrichment leading to water hyacinth and algae problems in the Hartebeestpoort Dam.

Surveys of threatened plants, birds, mammals, fish, reptiles and amphibians were undertaken and Red Data Books on each of these groups published.

In 1974, the then Department of Planning approached the CSIR and offered to provide funding for the National Programme for Environmental Sciences. By 1980, the programme had grown to such an extent that it was decided to reorganize and regroup the various sections. The marine pollution section was transferred to the marine sciences programme, the atmosphere section became the core of a new National Programme for Weather, Climate and the Atmosphere; the waste management section became a section of the National Materials Programme, and later a programme in its own right; the section on human needs, resources and the environment became a national programme of the Human Sciences Research Council in 1985.

National Programme for Ecosystems Research

The ecological component of the Environmental Sciences Programme (inland water, ecosystems, terrestrial ecosystems and nature conservation research) were grouped together and renamed the National Programme for Ecosystem Research which continued to provide a framework for the integrated study of complex environmental problems, ecosystems and the biosphere. These programmes as well as the transferred sections of the former National Programme for the Environmental Sciences continued to be supported substantially by the Department of Environment Affairs (previously the Department of Planning).

Aquaculture

A National Programme for Aquaculture Research was started in 1983 and concerned the human-controlled cultivation and harvesting of aquatic organisms for commercial use, management of natural systems to provide higher yields and the provision of scientific information to the various users.

Energy

To meet the situation created by the oil crisis of 1973 and the recurrent financial problems of 1979, which highlighted the impact that energy costs have on national economies, many countries started national energy research activities to reduce their dependence on oil, particularly imported oil.

The National Programme for Energy Research was started in 1978 on much the same lines as similar programmes in other countries. The object was to co-ordinate South Africa's non-nuclear energy research and in particular research funded by the State. In its early days, most of the funding was allocated to research at the local universities.

In 1981, however, after the establishment of the Department of Mineral and Energy Affairs and following intensive discussions with the sectors of the community concerned with energy, the research accent shifted to the broader research community and to focus specifically on local and regional problems. The universities continued to play a pivotal role in this concerted national action, but they were now joined by bodies such as the CSIR, Mintek, the Chamber of Mines and government departments. The National Programme for Energy Research became a comprehensive national research effort when the Department of Mineral and Energy Affairs formally recognized that the programme represented their non-nuclear research and development interests.

The programme was aimed particularly at making the best use of energy in South Africa as a contribution to the technological and economic development of the country. The impact of energy use on the environment, as well as the sociological implications, featured strongly in all aspects of the programme, which included -

- the whole spectrum of coal research and development (such as exploration, characterization, beneficiation, combustion and conversion to other products);
- the strategic implications of a potential oil shortage; and
- the challenging problem of meeting the changing energy requirements of the developing sectors of South Africa's population.

The need for an information system to serve the energy community soon became apparent. Through the initiatives of the programme management and with the co-operation of the Department of Mineral and Energy Affairs, the CSIR and others, a South African Energy Information System was set up and operated by the Centre for Scientific and Technical Information of the CSIR's National Institute for Informatics.

*Comprehensive
national research
effort*

Forum for experts

The energy programme was guided by the National Committee for Energy Research assisted by the National Committee for Coal Research and two divisional committees, one on transportation and the other on alternative technologies backed up by a task team on energy modelling. Research was funded by the CSIR, the Department of Mineral and Energy Affairs and various private sector bodies.

Microelectronics

The CSIR set up a Research and Development Co-ordinating Committee for Microelectronics in 1974 as a forum for experts in this field to review international trends and their implications for research in South Africa. The secretariat was provided by the Co-operative Scientific Programmes. In 1983, this committee, with the support of the Scientific Advisory Council, the CSIR, the universities and industry, decided to move positively towards stimulating research and development through financial support in selected fields which were considered to be of importance to local industry. These were:

- Design of integrated circuits - to meet the current and future needs of electronic equipment manufacturers in South Africa. The aims were to strengthen research and applications expertise as well as the infrastructure for integrated circuit design, and to encourage interaction with industry for the sharing of expertise and experience.
- Electronic devices - to encourage an understanding of the technology of specific devices and their applications in electronic equipment and their characterization through support of local prototype development.
- Processing technology - research into and development of the technology of critical steps in the chemical, physical and metallurgical aspects of the processing of electronic devices, in advance of local manufacturing needs.
- Failure analysis (and associated analytic and test methodology) to determine the causes of failure attributable to basic feedstock and processed local materials, production processes and device operation.

By the end of 1985 the focus was shifting to the identification of 'lead centres' qualifying for financial support in the form of 'seed money' as an incentive to undertake research for the development of technologies likely to be required in three to five years' time.

Materials

At the request of the South African Institute of Physics, a National Materials Programme was started in 1979 to review South Africa's position regarding its raw materials, the management of waste materials and the development of technology for the exploitation of neglected or underused local materials resources, and to support high-risk, cost-effective research programmes. The sections included metals and alloys (wear, Mo replacement in steels), ceramics (including pulverized fuel ash), polymers, renewable feedstocks (guayule natural rubber, ethanol from bagasse) and waste management.

When in 1983 the CSIR established a National Institute for Materials Research the National Materials Programme was phased out and further expansion was incorporated in the new Institute. Renewable Feedstocks and Waste Management became separate national programmes.

Waste management

Waste management, another of the environmental programmes funded by the Department of Environment Affairs, supported the development of technology for the growing waste management industry. When it became a separate programme in 1984, it concentrated on the following:

- Urban waste and the technology of waste collection and disposal, leachate management and the protection of groundwater, recycling and the implications of rapid urban growth.
- Chemical waste and such industrial waste as phosphogypsum, its disposal problems and re-use potential (for instance as a soil conditioner to rehabilitate acid soils), guidelines for the handling and disposal of industrial waste, and hazardous and toxic waste.
- Mineral waste and practical options for using and successfully marketing enormous quantities of coal ash (for instance in underground backfilling and as a cement extender).
- Organic waste and possibilities for recovering and making useful products from such organic wastes as sewage sludge.

Renewable feedstocks

Renewable feedstocks, which also became a separate programme in 1984, concentrated on the support of research and development in the following fields:

- The biological use of bagasse (waste sugar cane) through fermentation to produce such useful products as ethanol and single-cell protein.
- The feasibility of producing natural rubber in South Africa from guayule, a Mexican shrub.
- Plant cell suspension culture and other sophisticated techniques expected to be required for the agriculture and biotechnological industry of the future.

Each of these co-operative scientific programmes involved several individuals in different parts of the country, laboratories devoted to different disciplines and users in both agriculture and industry. Each programme drew on scarce scientific resources extending beyond the scope of any single organization or individual. These undertakings also proved to be effective in mobilizing the research and development potential of the country in fields which were so diversified, and in which so many agencies were involved, that no one organization could have met all the requirements.

It was also an activity which, by its very nature, generated many meetings, working groups, standing committees, specialist symposia and confer-

*Multidisciplinary
research effort
mobilized by CSP*

ences. The contribution of all those from outside the CSIR, who gave unstintingly of their time and energy to this aspect of these programmes, cannot be overestimated.

During the 1970s the successful development of these programmes owed much to the personal enthusiasm and involvement of the CSIR president, Dr C v d M Brink, and the deputy president, Dr F J Hewitt. It was their commitment and personal standing that won the confidence of the senior people in the agencies concerned, coupled with the effective staff-work of the programme managers and co-ordinators of the CSIR.

Biotechnology

New horizons in biological research and technology were opened up in 1973 with the development of what is known as recombinant DNA technology. This involves planned changes to genetic material in the living cells, known as 'genetic engineering', and depends very largely on a sound understanding as well as expertise in basic molecular biology. By 1983 the first product resulting from recombinant DNA technology, humulin (insulin), had reached the market. Modern biotechnology, as it came to be known, had arrived.

There was a tremendous upsurge of interest in this new field. Many new laboratories and companies were formed and governments greatly increased their allocation of funds for research in biotechnology and molecular and cellular biology. There was, however, widespread concern about the safety and long-term effects of these procedures. In South Africa the national committee for the International Union for Biological Sciences (IUBS) (Secretary: Mrs E P du Plessis of the International Relations Division of the CSIR) at a meeting in February 1977, appointed an advisory committee on genetic experimentation with Professor O W Prozesky of the University of Pretoria as chairman. In its report, presented in February 1978, this committee recommended that:

- A standing committee on genetic experimentation should be appointed under the auspices of the CSIR to advise on matters relating to genetic experimentation in South Africa.
- All proposed projects for genetic experimentation should be reviewed by this committee which would be responsible for classifying the level of biological 'containment' of the laboratories in which the proposed research would be carried out.
- Existing health legislation provided an adequate framework for any control of genetic experimentation which might be required and that the new technology should be fostered and not suppressed by too strict safety regulations and new controlling legislation.

The recommendations of the committee were accepted by the national committee for the International Union for Biological Sciences and a standing committee, known as SAGENE, was appointed by the CSIR with Professor Prozesky as chairman and secretarial services provided by the International

*Genetic
experimentation*

*Laboratory
containment*

Relations Division of the CSIR. The formal status of the committee was recognized by publication of a notice in the Government Gazette in December 1978.

In a letter to the president of the CSIR in 1980, Professors J S de Wet, C von Holt and D R Woods, of the University of Cape Town, drew attention to the urgent need for increased funding and co-ordination of research in molecular biology in South Africa. The CSIR responded by arranging a one-day colloquium in September 1981 which was attended by 30 scientists from universities, research organizations, state departments and industries. The CSIR was asked to appoint a 'task group' to survey the position in South Africa and recommend a plan of action. This task group, also under the chairmanship of Professor Prozesky, recommended that a co-ordinated national effort be made to foster biotechnology research, training and industrial opportunities. To this end it recommended that a national advisory body be created and that a 'national facility' be established to serve as a focal point linking centres of excellence active in this field.

These recommendations were submitted to the Scientific Advisory Council in March 1983 by Dr C F Garbers, president of the CSIR. In a comprehensive report he stressed the need for a national laboratory to strengthen long-term basic research in molecular and cell biology and for advanced post-doctoral training in this field.

The industries in South Africa likely to be affected by the new technologies were indicated as:

- Biomedical and veterinary products (antibiotics, drugs, vaccines, diagnostic materials, antenatal genetic screening).
- Agriculture (plant and animal breeding, growth rates, disease resistance, viral free stocks, diagnostics).
- Food and beverage industries (novel fermentation and food processing methods).
- Industrial and fine chemicals.
- Effluents, pollution and the environment.
- Mining industry (extraction of minerals from low-grade ores).

In October 1983, the CSIR appointed Professor Jennifer A Thompson, associate professor in the Department of Genetics at the University of the Witwatersrand, as director of a CSIR Laboratory for Molecular and Cell Biology. The laboratory was set up in the Department of Genetics at the University.

SAGENE continued to play an important role not only in monitoring biological containment of laboratories engaged in genetic experimentation but also in stimulating advanced training through a series of highly successful seminars and support for postdoctoral research training at centres of excellence in South African universities. Funds for this were administered through the biotechnology training programme of the Co-operative Scientific Programmes.

Molecular and cell biology research

Industrial research and development

Co-operative industrial research institutes

In submitting the Draft Bill for the establishment of the CSIR to the acting Prime Minister, Mr J H Hofmeyr, Dr Schonland emphasized that the development of industrial research should be regarded as 'an increasingly important side of scientific research – basic to the proper development of industry and efficiency of manufacturing processes'. He pointed out that although this was properly the concern of industry itself, the Government 'must possess machinery for advice on what measures to take to stimulate industrial research by remission of income tax and some assistance to research laboratories formed by groups of industries'. As examples of successful developments in this direction in South Africa, he mentioned the Leather Industries Research Institute, the Timber Research Laboratory of the Chamber of Mines in Johannesburg and the Experiment Station of the South African Sugar Association at Mount Edgecombe in Natal. He also mentioned that individual companies needed help and guidance on how to set about research and indicated that, in the initial stages, this might best be done in national laboratories or universities, the main cost being borne by industry.

Incentives for research by industry

The appropriate provisions to meet these requirements were included in the Research Council Act. After the establishment of the CSIR in October 1945 the intentions of its Council were explained in more detail in the publication *Objects and Policy of the CSIR* (Pretoria, December 1, 1945) (see p. 13):

'Looking at the problem of industrial research as a whole, the South African Council for Scientific and Industrial Research sees it divided up into the following categories:

- (a) Research by individual firms for the improvement of their raw materials, plant and processes. In this important matter the State has no direct financial responsibility. It can, however, encourage such activities by remission of taxation on research expenditure, including capital expenditure on buildings and equipment. It is understood that this is the intention of the Government and the Council wishes to endorse the wisdom of this step.

The CSIR has a function here to advise industrialists in the matter of research and the Government in regard to what research expenditures should be allowed for tax abatement.

- (b) Joint research by associations of firms engaged in the same or allied branches of industry. This is a development which has gone a considerable way in Great Britain and the United States. It enables small firms, which could not otherwise undertake extensive research, to unite to create a joint research association with common laboratories for the solution of problems met with by the industry as a whole.

It is desirable for the Government to encourage the development of such associations by a *pro rata* grant on the contributions by industry, provided some government agency is satisfied that the organization is on sound lines.

As in other countries, the CSIR is the appropriate agency for this work. It should undertake the necessary missionary activities in fostering research associations, fix the grant formulae on behalf of the Government and watch over the work of the industrial research laboratories to ensure that the grant is properly used. The laboratories should in all other respects be controlled by the industries themselves.'

The Federated Chamber of Industries strongly supported the concept of industrial research associations. It represented the view that industry, for its own good, should be forced to accept financial responsibility for research. The prevailing attitude was that it would be calamitous if South Africa's developing manufacturing industries were to accept the philosophy that research is something which should be left to the Government.

With this positive backing from the Federated Chamber, a campaign was launched for the establishment of industrial research associations in South Africa. Mr J E Worsdale, former president of the Federated Chamber of Industries and member of the CSIR Council, and Dr S G Shuttleworth, director of the Leather Industries Research Institute, toured the country on behalf of the Council and addressed gatherings of industrialists, explaining the CSIR scheme for co-operative industrial research.

The CSIR scheme provided for the registration of each industrial research association as an autonomous non-profit company receiving *pro rata* contributions from the CSIR which matched contributions by the industrial subscribers. A key feature of the scheme was that only industrial contributions guaranteed for five-year periods qualified for the maximum pound for pound subsidy. The agreement of member firms to this condition was a significant achievement. According to Shuttleworth this provision contributed greatly to the stability of staff and to the success of long-range research. With a view to concentrating the intellectual resources of the country, Dr Schonland arranged that each research association should be attached to a university and the director of the industrial research institute set up by the association should have professorial status with a seat on the university senate.

This initial step was followed by negotiations with 'action committees'. The CSIR established a Liaison Division to build on these foundations and to promote the whole idea of co-operative industrial research, either through research associations or through contract investigations in the national laboratories. It is remarkable that within two years, four industrial research institutes had been set up under this scheme as autonomous non-profit companies, in each case associated with a university.

In addition to the Leather Industries Research Institute, established at Rhodes University College, Grahamstown, in 1941 under Dr Shuttleworth and which became the first industrial research institute to be registered under the CSIR scheme in 1947, three new industrial research institutes were formally registered. They were the Fishing Industry Research Institute, University of Cape Town, which was registered in 1948 (director: Dr G M Dreosti), the South African Paint Research Institute, Natal University College, Durban, which was registered in 1949 (director: Dr L Whitby), the

*Industrial research
associations*



Dr S G Shuttleworth
Director, Leather Industries
Research Institute, 1941-1974

Sugar Milling Research Institute, Natal University College, Durban, which was registered in 1949 (director: Dr K Douwes-Dekker).

According to the 1950 Annual Report 'these research institutes are proving of great value to the industries which they serve and it is probable that, in all cases, the industrial subscribers will increase their contributions for the next five years. These early indications of the success of this scheme, under which industrial groups finance and manage their own research on a co-operative basis, have encouraged the Council in its belief that these industrial research institutes fully merit its confidence and continued financial support in the form of *pro rata* subsidies on guaranteed contributions.' In retrospect it is clear that the success of the scheme could be attributed to the guaranteed five-year period which served well into the 1970s when spiralling inflation necessitated provision for annual escalation.

Further progress in the field of industrial research was reflected in an agreement with the South African Wool Board, the National Textile Manufacturers' Association and the National Association of Worsted Textile Manufacturers for the establishment of a Wool Textile Research Institute as an autonomous co-operative industrial research institute under the CSIR's research association scheme. Management of this institute was taken over by the CSIR in 1960 and its development is reviewed on pp. 221-228.

Another significant development was the establishment of a Bituminous Binder Research Unit to investigate the use of locally produced bituminous materials in road and airport construction. Although this was a co-operative research unit, the running expenses being provided by annual contributions from the Department of Transport, the Provincial Administrations, industrial subscribers and the CSIR, it was decided that it would be controlled directly by the CSIR with the assistance of a steering committee. In 1955 this unit was incorporated in the National Institute for Road Research. Its development and activities are reviewed on pp. 246-534.

Leather Industries Research Institute

Rhodes University, Grahamstown

The 25th anniversary of leather research in South Africa was commemorated at the annual meeting of the Research Advisory Council of the Leather Industries Research Institute in Grahamstown in 1966. In congratulating the institute, the president of the CSIR, Dr S Meiring Naudé, outlined the growth of the institute from its early beginnings in the Chemistry Department of Rhodes University College under Professor W F Barker who personally collected the first 'research fund' totalling £30 from the tanning companies. In 1941 it became a research institute of Rhodes University College and in 1947 it was reconstituted under the research association scheme of the CSIR and registered as an autonomous, non-profit company. By 1966 it had grown into a research institute with a worldwide reputation and an annual income of R112 000.

One of the remarkable features of this institute was that it was supported and funded by the producers of raw materials, such as hides and skins and wattle extract, the processors of intermediate materials, such as the tanning

industry and the producers of the final consumer product, namely footwear (and, in this case, by associations of both employers and employees).

In the field of fundamental research this institute made valuable contributions to the elucidation of the structure of wattle tannin, the mechanism of vegetable tannage and the theory of chrome tannage, and in the study of soluble proteins of hides, which tend to become insoluble during curing, thereby affecting the quality of leather. Faced with growing competition from synthetic products and new techniques in footwear manufacture, the wattle and tanning industries increased their support for the institute, and the institute's 230-page textbook on wattle tannins, together with numerous publications in scientific and technical journals, assisted the industry in competing with rival tanning materials.

In research on footwear manufacture, the institute developed and patented a process for applying synthetic resins to a novel range of impregnated fabrics for use in stiffening the toes and heels of footwear. These resins were licensed to franchise holders in other countries such as Australia, New Zealand and Britain. The South African market was supplied by a new company formed for this purpose by the Footwear Manufacturers' Federation known as LIRI Components Ltd. The institute also developed valuable services in providing the footwear and tanning industries with prompt statistical data in the training of operators and in personnel management techniques related to productivity.

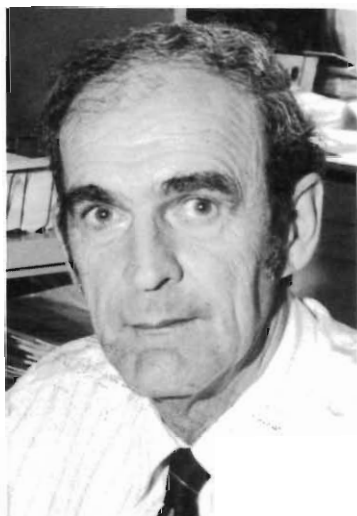
In the 1970s, in addition to the challenge of synthetics, there were increasing pressures on the tanning and leather industries to overcome effluent problems. North American tanneries, threatened with closure because of effluent problems, adopted a LIRI process, Liritan, which used wattle extract as a base instead of other tanning materials for the manufacture of sole leather. This reduced the effluent problem and also increased the value of sales of wattle extract to these countries by more than a million rand in 1972. Another market for wattle extract was opened up in the field of timber adhesives. These developments were based on the fundamental knowledge accumulated by the institute over the years of the structure of tannins and the chemical properties of the components of wattle extract.

Later achievements by the Leather Industries Research Institute included:

- Development of a preservation method for use on hides after animal slaughter and prior to hide receipt by tanners, which eliminated the need for saturating the water content with salt. This method uses antiseptic combinations, thereby reducing salt pollution which is a vital consideration in a country such as South Africa with its restricted water resources.
- Development of a new tanning method for shoe upper leather based on the use of mimosa (wattle) and aluminium. This produces leather similar to chrome tanned upper leather and avoids pollution from chrome tanning salts.
- In collaboration with the Water Research Commission practical methods for tannery solid waste and waste water management were developed and implemented.

Wattle research

Hides and skins



Dr D R Cooper
Appointed Director, Leather
Industries Research Institute,
in 1975

- Technical training for the leather and footwear industries was expanded considerably.
- The introduction of an extensive and sophisticated materials and finished product testing service for quality assurance and maintenance.
- The development of computer systems to assist in footwear manufacture.

When Dr Shuttleworth, director of the Leather Industries Research Institute since its inception, retired in 1974, the institute's budget was R250 000. He was succeeded by Dr D R Cooper, head of the institute's Hides, Skins and Protein Section and by 1985 the institute was spending over R1 million annually to serve industries with an output of well over R1 000 million.

Fishing Industry Research Institute *University of Cape Town*

The fishing industry was one of the first to take advantage of the opportunity offered by the 'research association' scheme of the CSIR to establish a cooperative industrial research institute, to be known as the Fishing Industry Research Institute (FIRI) in 1945–46. It was formally registered as a non-profit company in 1948. The industry's appreciation of the value of research in contributing to its development could, in large measure, be attributed to the success achieved during the war years by a research team in the Department of Chemistry at the University of Cape Town under the leadership of Dr W S Rapson, who later became the first director of the CSIR's National Chemical Research Laboratory. In accordance with CSIR policy, the research institute was to be affiliated with the University of Cape Town, but this was not formalized until 1950 following a resolution of the board of control of the Fishing Industry Research Institute. Accommodated originally in 1947 in temporary premises in the Department of Agriculture's Dehydration and Cold Storage Laboratory, Queen Victoria Street, and subsequently in 1948 in Portsworld Road, Sea Point, also by courtesy of the Department of Agriculture, the institute moved to a new building on the campus of the university in 1957. The Department of Agriculture lent the new institute basic laboratory equipment to avoid long delays in obtaining new equipment. Branch laboratories were opened at Walvis Bay, Lamberts Bay and St Helena Bay but were later discontinued.

Fish processing

The processing of fish products provided ample scope for research and development in disciplines as diverse as physics, engineering, chemistry, microbiology and nutrition. The institute's research programmes included the canning, chilling, freezing, salting and smoking of fish; the production, curing, storage and transport of fish meal, the production of body and liver oils and evaluation of their nutritional values; the production of fish protein concentrate (fish flour) for human consumption; effluent clarification and the recovery of solids during this process; abatement of odour emitted by fish meal factories; and the development and use of new fish products and of analytical methods applicable to all fish products.

The institute also undertook all routine analyses for commercial purposes, the costs being recovered from industry. These activities served to keep the institute in touch with the problems of the industry and provided a basis for

the formulation of regulations, specifications and standards for raw materials and finished products, and stacking and shipping procedures. The application of quality standards developed by FIRI for canned fish and frozen lobster were subsequently taken over by the South African Bureau of Standards, while the institute continued to inspect fresh, frozen, salted and smoked fish, fish meal and fish oil according to its own standards.

Permanent technical committees of the institute, representing all sections of the pelagic fishing and trawling industries, gave technical guidance to both the industry and the institute and assisted the industry in applying research findings in practice.

These wide-ranging activities were set in motion by Dr G M Dreosti, the institute's first director. A graduate of the Transvaal University College, Pretoria, and the University of Utrecht, Holland, he had 17 years' experience of food preservation with the Department of Agriculture and was head of the dehydration and cold storage laboratory of that department when he became director of FIRI in 1947.

With limited laboratory accommodation and equipment at his disposal, he immediately set about identifying the industry's most urgent practical technological problems and finding practical solutions. One of the Institute's early successes was to demonstrate what could be done to improve the quality of South African canned pilchards and the tomato sauce used in these packs. Adoption of these procedures and the factory inspection service introduced by the institute (later taken over by the S A Bureau of Standards) resulted, in due course, in South African canned pilchards being ranked among the best in the world. Problems connected with the quality of frozen rock lobster on the west coast were solved and this, together with a factory inspection service instituted by FIRI, enabled the industry to gain acceptance for this product in the lucrative American market. These two early practical successes did much to win the confidence of the industry. Further research by the institute enabled the rock lobster canners to eliminate discoloration and odour and flavour changes during storage. In a later development, live rock lobsters were air-lifted to overseas markets.

As a direct result of investigations by FIRI, the production of fish meal (one of the major products of the inshore fishing industry and an important ingredient in feeds for animals such as chickens and porkers) was increased by as much as 20 per cent. FIRI became a world leader in the fundamental study of the heating and spontaneous combustion of fish meal. Methods developed by the institute and adopted by international organizations for the storage of fish meal in warehouses and on board ship much reduced the risk of fire. Also as a direct result of FIRI's research South Africa was the first country to adopt the use of ethoxyquin as an anti-oxidant for the stabilization of fish meal.

When fish meal factories, such as those at Hout Bay and Lamberts Bay, were threatened with closure because of the nuisance caused by gaseous odours, the institute evolved a 'scrubbing tower' which reduced the problem to one which for years satisfied the residents. The basic principles embodied in what came to be known internationally as the 'Dreosti tower' were adopted worldwide.



Dr G M Dreosti
Director, Fishing Industry Research
Institute, 1946-1970

Fish meal

*Fish meal standards
developed*

As a member of the Scientific Committee of the International Association of Fish Meal Manufacturers, of which Dr Dreosti was for many years the chairman, FIRI not only made a significant contribution to the solution of problems affecting local and overseas producers of fish meal but also participated in international collaborative work on comparative tests of analytical methods and on quality criteria leading to standards specified by buyers of fish meal.

By 1970, the institute, through its success at finding acceptable solutions to practical problems, had done much to win the confidence of the industries it served. However, much more fundamental work had to be done to find lasting solutions, and in the following 15 years the institute had continually to refine techniques with the aid of more sensitive equipment to keep pace with the changing standards set by health authorities and the increasingly sophisticated food industries.

Furthermore, the institute had to face new challenges in assisting industry to contend with problems arising from increases in the cost of energy coupled with depletion in the fish population. As a result, attention was directed to better use of the catch, particularly white fish which constitutes most of the fish eaten, and the institute was much involved in experimental work on the handling and storage of fresh and frozen fish at sea.

In addition, FIRI developed methods for processing fish offal and fish not normally used for human consumption. Among these techniques were the FIRI flash-dryer and hydrolysis by acid or enzymes to produce materials suitable for use as food for people and animals. The development of canned pet foods broadened the range of the canning industry's products, while the technology of tomato sauce production for use in fish canning was much improved.

In this period the rock lobster industry was boosted by the development of trawling for lobster on sea mounts off the south coast at a depth of 200 fathoms. The institute played a major role in introducing a process to counter 'blackening' (melanosis) or discoloration of the tails frozen on board. By 1985 the production amounted to about 80 000 cartons of 4,54 kg each. Technology which enabled the export of cooked lobster in chilled form was also introduced. At that stage the entire South African rock lobster industry was earning R10 million a year in foreign exchange from the United States market alone.

A great deal was done to improve South African fish oil (already of a high standard) and FIRI became something of a centre of excellence in new analytical methods such as amino-acid analysis and oil and fat analysis by gas chromatography. This expertise enabled the institute to establish that South African fish oils are rich in a fatty acid which is widely regarded as beneficial in counteracting clot formation. A publication of these findings attracted international attention and resulted in increased exports at higher prices to Japan and Europe.

The institute also helped the industry to develop the potential of the mesopelagic (mid-water) fish - the so-called lantern fish. It established that the oil from this fish is of high quality, particularly for the oil hardening



Dr R J Nachenius
Director, Fishing Industry Research
Institute, 1970-1981

industry. However, difficulties were encountered in the extraction of the oil and in producing fish meal with an acceptable oil content. The institute also had a role to play in assisting the local canning industry to develop the potential of tuna which occurs in large numbers off the South African coasts.

At the end of May 1970 the first director of FIRI, Dr G M Dreosti, retired and was succeeded by Dr R J Nachenius. In 1979 he, in turn, was succeeded by Dr J P H Wessels.

Sugar Milling Research Institute *University of Natal, Durban*

The Sugar Milling Research Institute (SMRI) was established by the South African Sugar Millers' Association, the CSIR and the University of Natal in 1949 as a central scientific organization for research into the manufacturing problems of the South African sugar industry.

According to the *Sugar Journal* of March 1949, 'the undeniable need for the establishment of a research institute to advance the scientific development of the sugar manufacturing processes and other technological branches of the industry in this country has for long been appreciated by the milling companies, and the decision by them to initiate a policy embracing the form and scope of a technical organization which would most effectively meet these needs was unanimously approved.' The man to implement this policy was its first director, Dr K Douwes-Dekker, a former Director of the technological division of the famous Sugar Experiment Station in Java. He played a key role in identifying the industry's technological problems and in finding immediate practical solutions until such time as the institute had established a firm base for research aimed at longer-term solutions.

The institute started out in a temporary hut erected for ex-servicemen students by the university after the Second World War. In 1952 it moved into its new building on the Durban campus of the university. Additions were made at intervals to accommodate the growth in staff from the original five members to a complement of 54, plus six students, in 1985.

The Institute is financed jointly by the Sugar Millers' Association and the CSIR which each contributed R10 000 in the first year of its existence. The budget for the 1985–86 season, excluding R121 800 for the training division, amounted to R1 857 500 of which R492 000 (26,5%) was contributed by the CSIR and R1 152 500 (62%) by the association.

This growth is also reflected in the increased sugar production by the industry from 561 000 tons of raw sugar in the 1949–50 season to 2 369 700 tons of refined plus raw sugar in the 1984–85 season.

Over the years the institute was involved in many research projects to improve plant design and equipment and to reduce capital and operating costs, thereby increasing the quality of the sugar and quantity manufactured from a ton of cane.

The institute was able to assist in the extension of factories during the fast growth of the industry after 1952. Of particular importance was the correct



Dr J P H Wessels
Appointed Director, Fishing
Industry Research Institute,
in 1981



Dr K Douwes-Dekker
Director, Sugar Milling Research
Institute, 1949–1966

*Requirements of
international market*

use of steam for efficient heating and evaporation to limit the use of coal as additional fuel to the bagasse (the fibrous residue from sugarcane). A major undertaking, known as the mutual milling control project, was organized by the institute and monitoring of operations in co-operation with the sugar mills over a number of years gave sufficient data to obtain a clear picture of the essential features of the milling operation. The resulting improvements in milling and increased extraction of sucrose from cane from 1960 to 1967 was estimated to be worth R2 000 000.

In the 1950s attention was mainly devoted to 'direct consumption' (white sugars). In 1961, however, when South Africa became a republic and lost her Commonwealth sugar quota and had to compete on the world sugar market, the Sugar Milling Research Institute gave more attention to the quality of raw sugar (brown sugar) to meet the international demand. For example, to meet the requirements of the Japanese market, the industry adopted the practice, on the recommendation of the institute, of remelting the B-sugars and C-sugars (as produced by the mills) followed by recrystallization as A-sugar and coating it with final molasses. This procedure, which had been adopted in Java between 1930 and 1940 for the export of sugar to Japan, would have been familiar to Dr Douwes-Dekker. (The reason for this strange process in which a high purity product was purposely covered with impurities, was that Japan and some other countries penalized the import of refined sugar to protect their own refineries.) When the sugar terminal was built in Durban, it was decided to carry out the coating of sugar with molasses there just before the ships were loaded. This avoided the increase in colour which occurred with coated sugars during storage. The mixing at the terminal was controlled by an analogue computer to yield a more uniform product.

The institute also established that the poor filterability of South African sugar was due to the presence of starch and that this could be overcome by the addition of the enzyme X-amylase which degraded the starch during the milling process. This practice was adopted in 1968 and further enhanced the competitiveness of South African sugar on the world markets.

The institute adapted and developed the diffusion process in which water percolates through a bed of crushed cane to extract the sugar. By 1985 the process had been installed in several mills and accounted for 58 per cent of the cane processed by the industry.

The various sugar technology courses conducted by the institute in conjunction with the local technikons assured a steady supply of competent, suitably trained manpower for the industry. Furthermore, it served indirectly as a training ground for many of the top research workers and executives in the industry.

Technical services were provided to all 16 raw sugar factories in South Africa which, with the central refinery of the TONGAAT-HULETT group, were associate members of the institute. In addition, the institute provided a technical service to a number of affiliated member mills in the neighbouring states of Malawi, Swaziland and Zimbabwe. All research associated with the agricultural aspects of the cultivation of sugarcane continued to be handled separately by the South African Sugar Association's experiment



Dr M Matic
Director, Sugar Milling Research
Institute, 1966-1979

station at Mount Edgecombe. A close working relationship was maintained between the station and the SMRI.

When Dr Douwes-Dekker retired in 1966, he was followed by Dr M Matic, originally from Yugoslavia, and in 1979 by Dr A B Ravnö, a South African.

South African Paint Research Institute University of Natal, Durban

The South African Paint Research Institute (SAPRI) was established in 1946 in Durban in association with the University of Natal under the CSIR's research association scheme. Financial support was given by members of the Paint Manufacturers' Association. It was formally registered as a non-profit company in 1949. Unlike the other research associations established by the CSIR, the industrial subscribers to this institute were all concerned with the production of a consumer product and thus in keen competition with one another on the open market. They were not concerned with the processing of a common raw material, but rather with formulations of materials obtained from a variety of sources. However, as a result of progress in chemical technology, new synthetic materials were becoming available, and the industry recognized the need for scientific evaluation of these materials for a variety of applications. In fact, it had originally been proposed that the CSIR should establish a high-polymer research unit in association with this institute, but for various reasons the CSIR did not see its way clear to give effect to this recommendation. This limited the possibility that the institute would ever become fully viable. However, the membership was extended to include, in addition to the paint manufacturers, the producers of raw materials and major consumers, such as public utilities.

The National Building Research Institute (NBRI) also had an obvious interest in paint and related products for decorating and protecting buildings, structures and building materials, and so became involved in research into new paint systems and application techniques for exposed metal, cement, wood and wood structures. In view of this, a paint unit of the NBRI, comprising a research officer and assistant, was transferred to the Paint Industries Research Institute in Durban where it functioned under the guidance of a steering committee of which the director of the institute was a member. Unfortunately this arrangement did not prove to be satisfactory and was discontinued after some years.

In 1960, the South African Paint Research Institute moved from the premises which until then had been provided by the University of Natal, into its own new building at the southern end of the university campus. There it continued a limited but effective programme of investigation into paint manufacturing problems and the study of the failure and improvement of protective coatings used in South Africa's rigorous climatic conditions. Long-term studies were initiated with the guidance of a research advisory panel which included representation of member firms, the University of Natal, the corrosion group of the National Chemical Research Laboratory and the organic materials division of the National Building Research



Dr A B Ravnö
Appointed Director, Sugar Milling
Research Institute, in 1979



Dr L R Whitby
Director, South African Paint
Research Institute, 1949-1951



Mr G M Hamilton
Director, South African Paint
Research Institute, 1952–1971



Dr D W S Evans
Director, South African Paint
Research Institute, 1971–1973



Dr D E A Williams-Wynn
Director, South African Paint
Research Institute, 1973–1974

Institute of the CSIR. This included research into analytical methods (and undertaking analyses involving specialized apparatus beyond the means of individual member firms), accelerated weathering studies of paint films and outside exposure, and the use of a sea raft maintained by the institute for assessing the effectiveness of marine paints and anti-fouling compositions.

The first director of the institute was Dr L R Whitby from Britain. He was succeeded in 1952 by Mr G M Hamilton, also of the UK, who made a valuable contribution in establishing a sound technological base for the development of the paint industry. He retired in 1971 and was followed by Professor D W S Evans who, in turn, was succeeded in 1973 by Dr D A Williams-Wynn. With a background of experience in co-operative industrial research in South Africa with the Leather Industries Research Institute, Dr Williams-Wynn was well equipped to build up SAPRI, which had from the outset suffered from a lack of financial support from the paint industry. The CSIR offered to increase its own contribution on condition that matching support came from the industry to raise the annual income to a level recommended by a CSIR reviewing committee as the minimum required for effective research and development. For various reasons the industry could not meet this requirement and after extended negotiations it was decided that the institute in its existing form would be closed at the end of 1974. Its assets were transferred to the University of Natal.

This development, unfortunate though it was, emphasized that industries are prepared to co-operate in research and development if their production is based on local raw materials and marketed at an administered price, in other words, if they are not in direct competition with one another for a share of a limited consumer market. Another factor is that co-operation in research and development is more likely between a fair number of firms of similar scope and size. At the time of the closure of the institute, however, a spate of takeovers had resulted in rationalization in the South African paint industry to the extent that it had come to be dominated by a few major groups, each with strong international affiliations and thus having access to sophisticated research facilities overseas.

Regional research and liaison

Dr Schonland was a great believer in personal consultation as a means of obtaining advice on all matters pertaining to the development of research. With this in view, he arranged for the CSIR Council to meet in at least one centre away from Pretoria each year. The following are extracts from CSIR Annual Reports:

In 1947: 'The three-day meeting was held in Port Elizabeth, which gave the Council the opportunity of holding discussions with the Midland Chamber of Industries and other interested persons and of visiting the Leather Industries Research Institute at Rhodes University College, Grahamstown'. Then again in 1948: 'Two meetings of the Council have been held, each lasting three days. One of them took place in Cape Town and gave the Council the opportunity to hold discussions with the research committees

of the Universities of Cape Town and Stellenbosch, the Cape Chamber of Industries and the Board of Control of the Fishing Industry Research Association. The discussion with the Cape Chamber was made the occasion of a general examination of proposals for research into industrial effluents. At the invitation of the Board of the Fishing Industry Research Institute, the Council paid a visit to the Institute in its new but temporary quarters in Portsworld Road and the President of the Council formally opened the Institute.'

This pattern was repeated in 1949: 'The Council held three meetings during the year, one in Johannesburg, one in Pretoria and one in Pietermaritzburg. In the course of these meetings it had valuable discussions with the Research Committees of the University of the Witwatersrand and the University of Natal, the Executive Committees of the Natal Chamber of Industries, the Paint Industries Research Institute and the Sugar Milling Research Institute.'

In the course of these visits and meetings local personalities took the lead in mobilizing those interested in research on local and regional problems. These individuals were invited by the CSIR to serve on regional research liaison committees, which were valuable points of local contact for the Liaison Division of the CSIR. Following the lead of the Eastern Cape where the Midland Research Liaison Committee was set up under the chairmanship of Mr H Schauder, a leading industrialist, similar committees were formed in Natal under Mr T E Peppercorn (chairman of Dunlop Limited) and in the Western Cape under Professor W J Pretorius (chairman of the KWV). The need and scope for industrial research was actively reviewed by these committees in collaboration with the Liaison Division.

Regional research liaison committees

The standing and enthusiasm of these chairmen contributed greatly to the stimulation of local interest. The exchange of ideas between scientists and industrialists was encouraged through these committees, the members of which played an active role in arranging for research workers to visit factories in their areas and to deliver public addresses and lectures. In 1955, for example, these activities included the following: a symposium on heat economy in industry, organized by the Western Cape Regional Research Committee in Cape Town; a one-day seminar on scientific and technical information services, organized by the Natal Regional Research Committee in Durban; lectures in Cape Town, Port Elizabeth and Durban on corrosion; and lectures in Cape Town on incentives and human relations in industry. In Port Elizabeth there was a one-day seminar and public lecture on low-cost housing, a lecture on personnel research in South Africa, a lecture on clay problems in relation to research in South Africa, and a public discussion on physics in relation to industry, organized to coincide with a visit by senior members of the staff of the National Physical Laboratory of the CSIR. In November 1955 a symposium in Pretoria on research and regional development was attended by members of the CSIR and representatives of the CSIR's regional research committees, the Natural Resources Development Council and the National Council for Social Research.

In the early days, these rather informal regional committees played a significant part in shaping the policies and attitudes of the CSIR and in

informing local industrial communities and regional authorities on the role of the CSIR. In due course, as the CSIR organization developed and research institutes or units were established with their own regional units, laboratories or offices to meet specific needs, the emphasis changed. Because of the increasingly important role of the Provincial Administrations in regional planning and development, the need arose for a procedure for annually reviewing the activities of the CSIR's national research institutes in certain regions where they undertook major contract studies on behalf of branches of Provincial Administrations, major municipalities and regional authorities. These studies were concerned mainly with community services such as water supply and effluent disposal, housing, roads and transport, air pollution and harbour development. To meet this need, the original regional committees were replaced by more formal committees in Natal, the Cape Province and South West Africa. An essential feature of these committees was that meetings were 'chaired' by the president (or a deputy president) of the CSIR and attended by the Administrator, members of the Executive Committees of the Provincial Councils and the Provincial Secretaries of the provinces concerned (or their equivalents in the case of South West Africa).

Techno-economics

In seeking to identify the research needs of industry and the best ways of meeting them, the Liaison Division had to take into account not only the CSIR Council's commitment to the concept of co-operative industrial research institutes, but also the potential of the CSIR's developing national research institutes.

To meet this situation liaison officers were attached to the National Chemical Research Laboratory and National Physical Laboratory of the CSIR to help with technical enquiries from industry. When necessary, they obtained advice and information from specialists in the CSIR and other laboratories, from the literature, with the assistance of the Library and Information Division, and from specialists in other countries through the overseas offices of the CSIR. If, as often proved to be the case, no satisfactory solution could be found from available information or expertise, they assisted in the negotiation of research contracts between the industrial enquirers and the appropriate research laboratory of the CSIR. For example, in the year 1947-48, 53 such contracts had been dealt with for an amount of £34 560. This amount may seem rather a modest figure, but it represented a promising start at a time when industrial research and indeed all the manufacturing industries in South Africa were in an embryonic stage. Furthermore, the facilities of the CSIR laboratories were still limited and many of the staff members were young and undergoing further specialized training. There was also much to be learnt about drawing up contract agreements as at that stage the whole concept of contract research was something of a novelty, the only available 'models' being those of the Battelle Memorial Institute and similar non-profit institutes in the USA.

To encourage support for long-term research by industrial firms or associations of firms in fields in which they themselves were not equipped and

which did not warrant the establishment of separate co-operative industrial research institutes, industrial research fellowships were introduced in 1948 (following the practice of the Mellon Research Institute in Pittsburgh, USA). Under this scheme, an individual firm or association of firms could guarantee the salaries and special expenses of one or more research workers to be engaged by the appropriate national research institute of the CSIR, which would provide accommodation, general facilities and specialized supervision as an indirect subsidy.

The first such fellowship was for the Blue Lime Manufacturers Association to carry out research into materials produced from dolomite and high magnesia limestones. By 1950 two fellowships had been established by the South African Wool Board for fundamental chemical research on wool and its by-products, and another by African Explosives and Chemical Industries Ltd (AECD) for research on lightning protection. Subsequently, fellowships were supported in the National Chemical Research Laboratory in fields such as marine stand-oils, the processing of groundnuts and the treatment of dairy effluents. Through the National Building Research Institute, the Institution of Municipal Engineers supported three fellowships for investigating methods to prevent the corrosion of concrete sewers. Five fellowships were created by the National Housing and Planning Commission for research into methods of reducing the costs of housing for black people.

These activities of the Liaison Division emphasized the need for a more systematic analysis of technological research requirements, as an aid to identifying priorities in the planning of long-term research and development programmes. For example, in 1954 liaison officers were involved with CSIR research laboratories and the overseas offices in surveys of the patenting of inventions, laboratory design, food technology (with special reference to baking and flour technology), composting of municipal wastes, industrial microbiology, training facilities for microbiologists and production engineers, and South African sulphur resources. The object of these surveys was to provide a technical and economic background for the appraisal of research needs in these fields. Later, these techno-economic reviews were extended to include the wood processing, cotton textiles, sisal, essential oil and foundry industries, the latter with special reference to foundry sands. A symposium on problems of ceramic raw materials was arranged and, as a result, a technical liaison committee for the whiteware and brick industries was formed.

When, by 1957, all the obvious requirements of this kind were being met, it was necessary to identify more systematically the longer-term research needs of industry in terms of economic objectives. For this purpose a graduate in business administration was appointed (Dr R R Tusenius, later director of the School of Business Administration at the University of Stellenbosch) under whom an Industrial Economics Division was formed within the Liaison Division (later the Information and Research Services). The activities of this division were co-ordinated with those of the Building Economics Section of the National Building Research Institute and the Road Economics Section of the National Institute for Road Research under the professional supervision of Dr Tusenius.

Industrial research fellowship

Surveys of technological research requirements

Industrial research units

In 1960, the CSIR Council, faced with a limitation on funding by the State, set up an Advisory Committee for the Development of Research for Industry to review its services to industry and the funding of CSIR research by the business sector. This committee also undertook five-yearly reviews of the four co-operative industrial research institutes (for the leather, fishing, sugar milling and paint industries).

On the advice of the committee, the Council decided that instead of calling upon industries to share the costs of setting up separate autonomous co-operative industrial research institutes, a more modest start could be made by establishing units within the framework of the CSIR's laboratories. Such units would have the advantage of bringing together activities relevant to a particular sector of industry which at the time were scattered around in the various research institutes. The industry concerned, in return for subscribing to the cost, would have a say in setting the objectives and in advising and directing the allocation of funds. A number of these research units were set up, such as the Timber Research Unit which eventually became the National Timber Research Institute (see p. 228); the Sorghum Beer Research Unit (see p. 195) within the National Chemical Research Laboratory; the Air Pollution Research Group (see p. 132), established with funds contributed by a number of different bodies for research co-ordinated by the CSIR and undertaken by the National Physical Research Laboratory and the Chemical Engineering Research Group. Two units, the Ceramics Research Unit and the Corrosion Research Group, worked in the National Building Research Institute and the National Chemical Research Laboratory.

In 1960, Foskor decided that its research fellowship for the study of the production of super-phosphate from the Phalaborwa concentrates should be developed as the nucleus of its own research department. Until it reached a suitable stage of growth, however, it should be situated within the National Chemical Research Laboratory. This type of arrangement for encouraging an industry to undertake research and eventually to set up its own research department was admirably suited to the objectives and policy of the CSIR, but its potential, unfortunately, was never fully used by industry.

To assist the Advisory Committee for the Development of Research for Industry in reviewing the activities of the existing industrial research institutes as well as the newly formed research units and the industries they served, the professional services provided by the Industrial Economics Division were oriented in two main directions - techno-economics under Dr J H Visser and research economics under Dr R J van Wyk. To identify the research needs and opportunities for technological innovation in industrial sectors for which there was no specific provision, the techno-economics section carried out surveys of sectors such as packaging, basic chemicals (in co-operation with the Board of Trade and Industry), pulp and paper, sorghum beer, phosphate products, sawmilling, textiles, motor components and metals engineering. These surveys were undertaken in collaboration with specialists from one or more CSIR institutes. In addition, incentive schemes adopted in other countries for promoting technological innovation in industry were reviewed.

The main aim of the research economics section was a better understanding of the economics of technological innovation. Following the lead of the Organization for Economic Co-operation and Development in Paris, it was decided that as a start the CSIR's research expenditure for the various sectors of the economy should be analysed. It was soon found that such analyses, to be of any use, should embrace not only the CSIR but all organizations in South Africa engaged in research and the funding of research. These national surveys of funds and manpower devoted to research and development were undertaken on behalf of, and funded by, the Scientific Advisory Council. To facilitate international comparisons, the procedures of the Organization for Economic Co-operation and Development were adopted. The surveys were started in the financial year 1965–66 and developed and refined under the leadership of Mr L van den Heever. They were continued by Mr H Müller and Mr H P Hofmeyr every two years. (In 1979 they were extended to cover the human sciences in co-operation with the Human Sciences Research Council). Analyses of these data indicated that national expenditure on research and development amounted to some 0,6 per cent of the gross domestic product; that the government sector played a dominant role, both as a performer and financier of research and development; and that both in performance and financing of research, the academic and business sectors lagged far behind the advanced industrialized countries.

In the Industrial Economics Division there was characteristically a rapid turnover of staff, particularly at the senior level. When Mr L A Beard, who succeeded Dr R R Tusenius, left to become assistant manager of the Deciduous Fruit Board and later managing director of Protea Holdings, he was followed by Dr A E Scheurkogel who, in turn, left to become professor of economics at the University of the Orange Free State, and later professor of industrial economics at the University of Stellenbosch. The next head of the division was Dr J H Visser who left in 1967 to become the first executive director of the newly-founded National Productivity Institute. Although they and many of their senior colleagues moved to key positions in other organizations, they continued to make significant contributions to the better understanding of the role played by technological innovation in the development of the economy.

In this context the key issues in South Africa at that time were reviewed by Dr Meiring Naudé in his presidential address to the Associated Scientific and Technical Societies in November 1965:

'In mature economies, economic growth depends largely on the rate at which technical progress is infused into industrial firms. This rate can be measured by the rate of replacement of old equipment with new. However, circumstances in South Africa during the past two decades were those of a younger, developing industrial economy in which progress depended to a great extent on the rate at which existing technology could be introduced into a new environment. Obviously, this is a process which is greatly complicated when it occurs during a period of rapid technological change such as that experienced after the Second World War. It could be said that South Africa has been undergoing an industrial revolution while the whole

*National surveys of
research expenditure*

*Technological
innovation and
economic growth*

of the African continent is in a state of social and political turmoil and the world at large is experiencing a technological revolution.

'This is a situation which has placed a great strain on all services, and particularly on a research organization such as the CSIR, for science is at the heart of all this revolutionary change. Science has indeed been described as the yeast in a ferment of change.'

The decade of the 1970s, however, with its rapidly changing international situation, in which traditional economic considerations applied to a diminishing extent, required a reconsideration of questions such as import replacement, export promotion, and greater national self-sufficiency. This entailed, among other things, a re-evaluation of locally available raw materials and the capacity to use them in the manufacture of commodities in open competition with other countries. This, in turn, created a need for a more dynamic and immediate technological awareness and a more effective interaction between the economy and technology.

Industrial market research

To meet the requirements of this situation, Dr M J C van Vuuren, who succeeded Dr Visser as head of the Industrial Economics Division, introduced the concept of industrial market research, the stress being on a particular product instead of sectors of industry. In doing so, a field so ready and ripe for development was uncovered that the division was almost overwhelmed by the demand for contract studies. This change of emphasis was reflected in the adoption of a new designation – the Group for Techno-Economic Studies.

Then came the fuel crisis and concern about the availability of feedstocks for the chemical industry. The president of the CSIR, Dr C van der Merwe Brink, found that the major chemical industry did not have the whole picture of the availability of chemical products and the Group for Techno-Economic Studies was asked to identify and analyse import/export statistics for chemical products. This project was assigned to Dr J P Reinhardt, who later took over from Dr F V Viljoen as head of the group. On Dr Reinhardt's recommendation a computerized data bank on import/export statistics was started in 1974 as an aid to identifying possible future bottlenecks in the supply of chemical feedstocks. This was so successful that similar data banks were subsequently established for pharmaceutical, engineering (including electronics), biological and agricultural products, and analyses based on these data banks were published from time to time. This established a sound professional basis for this type of market analysis for identifying research needs in terms of market opportunities as an aid to decision makers.

By 1976 the biennial surveys of research expenditure were indicating a slow but steady increase in industry's share in the financing of research. The need for accelerating this process, particularly in relation to the production of finished products from South Africa's raw materials, was stressed in the report of the Reynders Commission on Export Promotion. Reacting to this report, the Scientific Advisory Council proposed that the CSIR should step up its efforts to promote research and development in industry. Initially an amount of R250 000 a year was provided in the budget of the CSIR - the so-called 'Technology Development Fund'.

Industrial research bursaries

As a first step, a pilot scheme for industrial research bursaries, based on studies of similar incentive schemes adopted in other countries, was introduced. These bursaries were intended to provide young graduates with opportunities for training in research in the actual industrial environment. Proposals were invited from firms which were prepared to employ a research bursar for a specific and well-defined project. The CSIR offered to contribute the salary of the bursar (within specified limits). At the same time, to strengthen the links between industry, the universities and research organizations, the CSIR insisted that the projects should be reviewed at regular intervals by a steering committee on which, in addition to a supervisor from the firm concerned, there should be representatives from a research institute and a university. The funding of the scheme provided for the appointment of four bursars a year, each for a period of three years. This scheme was moderately successful. The arrangements under which the scheme was managed proved to be most satisfactory, but the CSIR was by no means overwhelmed by proposals from industrial firms. The CSIR's main effort in this direction came to be concentrated mainly in the 'joint venture' scheme of the South African Inventions Development Corporation (see pp. 102–106).

In 1979 it was decided to terminate the Advisory Committee for the Development of Research for Industry and to replace it by *ad hoc* working groups with specific objectives. For example, in accordance with the objectives of the 'Technology Development Fund', a working group was established between the CSIR and the Steel and Engineering Industries Federation of South Africa (SEIFSA) to stimulate innovations in the metals and electrical engineering industries.

Under the auspices of this working group, arrangements were made for intensive visits to CSIR research institutes by representatives of SEIFSA associations, and audiovisual programmes were presented by the CSIR to SEIFSA members in Durban, Cape Town and Port Elizabeth. During 1980, a joint CSIR/SEIFSA technical mission visited Taiwan and Israel to gather information on successful measures introduced in those countries for innovative development in the metalworking and electrical industries. Special emphasis was placed on the applicability of such measures in South Africa in regard to the creation of job opportunities, manpower development, improvement of productivity and technological development for import substitution and export promotion. A report on the findings of this mission was prepared for presentation to a CSIR/SEIFSA conference on technological innovation held in February 1981. One of the main outcomes of this activity was the accelerated development of the services of the CSIR's Production Engineering Advisory Service (PEAS) for technology transfer to small and medium-sized firms.

Although by 1985 statistical analysis indicated that expenditure on research and development by South African industries was increasing appreciably, it still fell far short of corresponding levels of expenditure in the advanced industrialized countries. However, the growing emphasis on technology transfer was a significant pointer to future trends in the CSIR's involvement with industry.

Emphasis on technology transfer

Inventions development

From the outset it was the philosophy of the CSIR that research undertaken in a State-supported research organization could not be regarded as an end in itself, and that procedures should be developed to ensure that the results of research would be put to practical use. It was hoped that the system of undertaking research for industrial firms under contract arrangements would ensure that the firms concerned would, because of their investment in the research, make use of the results. Ownership of patent rights with regard to any inventions which might arise were written into the terms of all such agreements.

Policy on inventions

The conventional ethic of the time was that as results of research initiated by the CSIR's own laboratories were financed by public funds, they should be public property and made public in the traditional form of publication in research journals of international standing. However, there was a growing recognition in Europe and North America that before any new idea or process was ready for commercial exploitation, a costly development programme was invariably necessary and that industrial undertakings were understandably reluctant to accept this financial risk without protection from competition for a reasonable period in which to recoup the investment in development costs. As the patent system had been originally devised to provide just such protection while, at the same time, requiring publication, in other words 'laying open' of the invention for the advancement of knowledge and technology, it became the policy of the CSIR to patent inventions and to grant licences to individual firms.

- Early success was achieved in the 1950s with several patents covering the system of single-crystal frequency control of radio equipment and the Tellurometer system of radio distance measurement invented by Dr T L Wadley of the National Institute for Telecommunications Research. These two inventions provided an effective base for an inventions development activity. One of the early lessons was that, to ensure the rapid transition of an invention into a commercially sound proposition, it was important to interest potential users at an early stage and for the research laboratory to enter into a joint venture with an industrial concern for this purpose. In 1961 it was reported that the total value of inventions manufactured under licence from the CSIR exceeded R6 million and that up to that date the CSIR had earned royalties to the value of R450 000.

SA Inventions Development Corporation (Saidcor)

At that stage it became evident that this activity should be managed by a separate body with a mandate to undertake the patenting, licensing and development of inventions not only on behalf of the CSIR but also of government departments, public bodies, universities, industrial firms and private inventors. Proposals to this effect were approved by the Government and in 1962 the South African Inventions Development Corporation (Saidcor) was set up as a statutory body under the CSIR in terms of the Inventions Development Act (No. 31 of 1962). It came into operation on 8 August 1962 with a board of directors consisting of Dr S Meiring Naudé (chairman), Mr G S J Kuschke, Mr D Lion-Cachet, Dr P E Rousseau and Dr N Stutterheim (alternate: Mr D G Kingwill). All the CSIR's existing

patents and licences as well as the staff of the Inventions Development Division of the CSIR's Information and Research Services were transferred to the new corporation, with Mr A M Schady as the manager.

The corporation's first Annual Report for the tax year 1962–63 reflected that it had been launched with an authorized capital of 200 000 shares of R1 each, of which 100 000 had been issued. Subsequently the issued share capital was expanded to R5 000 000 in successive stages.

Initially, the corporation was mainly concerned with the patenting and licensing of inventions originating in the CSIR and the universities. These activities helped to provide new opportunities for South African industry to launch new high technology products resulting *inter alia* in the establishment of two new South African companies both manufacturing instruments of a strategic nature, the bulk of which were exported.

Selected examples of some of the more successful patent licensing agreements provide an indication of the contribution of the corporation to the industrialization and commercialization of inventions by South African research workers which were patented and licensed by the corporation:

- A South African company, set up with help from the corporation to manufacture the Tellurometer system of distance measurement, maintained the leading position in the world market for this highly sophisticated electronic equipment for over 25 years. Foreign exchange earned by the company during this period amounted to some R60 million.
- An improved process for the preparation of gamma globulin for immunization against certain diseases by intravenous injections earned R4 million in royalties from a foreign licensee.



Mr A M Schady
Manager, SA Inventions
Development Corporation,
1962–1982



Various models of the Tellurometer system of distance measurement. The bottom right photograph shows Dr Trevor Wadley, inventor, using a recent model with some assistance from a representative of the manufacturing firm, Plessey SA Ltd.



The 'Impact Roller', developed by the National Institute for Transport and Road Research in collaboration with the South African Inventions Development Corporation



- The Bardenpho system for liquid effluent treatment which makes use of a biological process to remove nitrates and phosphates and yields a high quality effluent was in use in 15 major effluent treatment installations in South Africa, and in three in North America.
- By 1985 the advanced Scheffel bogie, which drastically reduced wear on train wheels and rails, was in commercial use, with great success, not only in South Africa but also in North America, Australasia and the Middle East, and licence agreements were concluded in the Far East and Europe. Royalty income approximately balanced the corporation's investment of R600 000 in development and commercialization of this invention, but royalty income was expected to increase.
- Two products of research on carbon fibre surgical implants, known as the 'bollard and toggle' and which were part of a ligament repair kit, were developed at the CSIR. They were manufactured in South Africa under licence to the corporation and marketed worldwide.
- The manufacture of improved furnace cartridges for removing slag rings from rotary furnaces, invented at the CSIR and licensed to a firm in the Western Cape, had the prospect of reducing imports to the extent of R10 million a year as well as of opening up an export market.
- The 'Impact Roller' – essentially a square roller – developed by the CSIR's National Institute for Transport and Road Research for use in soil compaction in, for example, road, rail and dam construction, was manufactured and used successfully in South Africa under licence to the corporation. Prospects of opening up an international market were good.

- In 1980 the corporation took on the patenting, development and commercialization of the so-called Interlocking Box (ILB Cardboard Carton) invented at the Deciduous Fruit Board. These boxes have the advantage of convenience in stacking with better protection for contents such as fresh fruit. By 1985 royalties had yielded R130 000 and agreements with foreign licensees had the prospect of yielding some R300 000 a year.

From the outset it was the intention that the corporation should be run as a business and that it should pay its way in the long term. Total earnings over the years amounted to about R9 million which was comfortably in excess of its total operating costs of R4 million. However, the surplus of income over operating costs, amounting to about R5 million, proved insufficient to meet the increasing calls on the corporation to invest in further innovative development work.

Thus, in 1974, a major step forward was taken when Saidcor negotiated a long-term loan facility of initially R5 million with the State. These funds enabled Saidcor to introduce a new scheme to encourage individual industrial firms to invest in research and development work through 'joint ventures' with the corporation. The following are selected examples of these Joint Ventures which aimed at the development of high technology products believed to have attractive long-term profit potential:

Joint ventures

- The corporation contributed to the costs incurred by the firm Knorr-Bremse in building a test-frame for testing a braking system for trains of up to 200 wagons to ensure that the system satisfied the requirements of the American Association of Railroads in all respects. Successful completion of this testing procedure not only enabled Knorr-Bremse to supply braking systems of mainly local manufacture to the South African Transport Services but also to export highly sophisticated equipment with the assurance that it met the stringent and internationally accepted standards of the American Association of Railroads. This illustrated the role of the corporation in facilitating the implementation of new technology by a South African firm, resulting in import substitution as well as the export of a highly sophisticated product.
- The Corporation assisted the firm Electromatic to develop a system for determining the axle load of vehicles in motion. This system won recognition as the best available internationally and 80 per cent of these devices were exported. With further support from the corporation, Electromatic developed a system for the identification of railway trucks which was accepted by the SA Transport Services for use on the Richards Bay railway against strong competition from multinational companies. The system also attracted interest from foreign countries.
- A contribution of R80 000 by the corporation enabled a South African subsidiary to adapt a process developed by its foreign parent company for use in recovering fine coal from coal mine effluent. By means of this process, 800 000 tons of coal lost in the washing process each year, worth R12 million, could be recovered at a cost of R9 million. Thus the corporation, at relatively low cost, promoted the application of improved technology to enhance profitability and earnings of foreign exchange.



Mr A A de Waal
Appointed General Manager,
SA Inventions Development
Corporation, in 1982

- Glamosa, a small firm manufacturing speciality glass products in Natal, was helped to acquire technology developed at the CSIR for the manufacture of a range of glass products previously imported. In this way the corporation brought about the effective transfer of new technology, and assisted a small firm to increase its competitiveness through the better use of local raw materials.

By 1985 the corporation's investments of venture funds in industry amounted to over R15 million, of which about 45 per cent was generated internally from its royalty earnings, the balance being derived from long-term State loans. Mr Schady, who had headed the CSIR's Inventions Development Division from 1956 and became the corporation's first manager in 1962, retired in May 1982. He was succeeded by Mr A A de Waal, a project manager of the corporation.

Information and communication

After the passage of the Research Council Bill in Parliament in May 1945, Dr Schonland appointed a professional assistant to assist him in his capacity of scientific adviser to the Prime Minister and in the preparatory work involved in setting up the CSIR. To this post he appointed Major DG Kingwill, of the meteorological section of the South African Air Force. The holder of an MSc degree in physics from Rhodes University College, he joined Dr Schonland and his secretary, Miss M A Murray, in July 1945 in Central Street, Pretoria, in office accommodation made available by the Department of Commerce and Industries.

When in September they moved to the Mint Building in Visagie Street, the staff was augmented by the secondment of Mr L A W Skinner, an assistant secretary in the Department of Reconstruction, who with his assistants, laid the foundation for the CSIR's administration until the appointment of Mr J R Sorrie as secretary/treasurer. With this appointment, provision was made for the internal services required by the president, such as budgeting, accounting, staff regulations and appointment of staff and other professional secretarial services, accommodation and transport.

This freed the professional assistant to concentrate on the development of external services, such as the support of university research, international relations and the promotion of industrial research. He also provided a 'clearinghouse' on information not only about the CSIR itself but about scientific developments elsewhere. To an increasing extent he became involved in 'industrial liaison', dealing with matters such as the establishment of industrial research associations, technical enquiries including a field liaison service, negotiation of industrial research contracts including patents and inventions development, and remission of income tax on industrial research expenditure. In 1948 all these activities were combined in a Liaison Division under Mr Kingwill.

In many ways, the functions of the Liaison Division and the Library and Information Division (the latter had been set up in April 1946) were

Liaison Division

complementary and they co-operated closely, particularly in activities such as dealing with enquiries for technical information and what they referred to as 'organizing information on sources of information'. In 1958 the two divisions merged under Mr Kingwill and became the Information and Special Services Department when the head of the Library and Information Division, Miss Hazel Mews, resigned to take up an appointment in the Department of English at the University of the Witwatersrand. In 1962 the department was renamed the Information and Research Services (IRS) and Mr Kingwill was promoted to the rank of director. Mrs J I Snyman succeeded Miss Mews as head of the library.

At this stage the activities of the IRS included the information services of the CSIR library, publishing, public relations, science writing, international co-operation in science and associated scientific liaison offices overseas, techno-economics and industrial research development, inventions development, university research grants, medical research and co-operative scientific programmes. Through the unification and integration of these activities and their close association with a broad spread of basic and applied research activities on a single site, an opportunity was created for the development of information services which was in some respects unique. With the exception of the library and related functions concerned with the collection and dissemination of scientific and technical information all these activities were closely associated with the office of the president and the CSIR executive.

During the next 20 years some of the earlier activities of the IRS developed to the extent that they could be hived off as separate entities. The South African Inventions Development Corporation was established in 1962 (see p. 102) and the Co-operative Scientific Programmes in 1975 (see p. 73). University Research Grants (see p.45) were transferred back to the Administrative Services Department and then in 1984 were linked with the Co-operative Scientific Programmes to form the CSIR Foundation for Research Development. In 1980 the library and information services became a separate institute of the CSIR, namely the Centre for Scientific and Technical Information, and in 1984 was coupled with the CSIR's Centre for Computing Services to form a National Institute for Informatics. Thus, from 1980 onwards, the Information and Research Services was responsible for the Group for Techno-Economic Studies, support for co-operative industrial research institutes, the International Relations Division and the Scientific Liaison Offices overseas, publishing and publicity services, a symposium secretariat, management of the CSIR's Conference Centre and the visitors' and reception office. After Mr Kingwill retired in 1982, he carried on as acting director until the end of 1983 when he was succeeded by Dr L R P Butler, at that time scientific counsellor and head of the CSIR office in Bonn.

Scientific and technical information

One of the primary functions entrusted to the CSIR in terms of the Research Council Act, was to 'establish and control facilities for the collection and dissemination of information in connection with scientific and industrial matters'.



Mr D G Kingwill
Director, Information and
Research Services, 1962–1982



Dr L R P Butler
Appointed Chief Director,
Information and Research
Services, in 1984

Dr Schonland emphasized the importance he attached to this function in *Objects and Policy of the CSIR (an initial statement)* in 1945: 'Many of the industrial and applied scientific activities in South Africa do not require research so much as the intelligent application of the results of research. For this we need a well-organized flow of scientific information obtained without delay from the best sources in the world. Organized as a scientific and technical information service, such a flow could save this country large sums of money.'

This presented a daunting challenge. One of the difficulties in a young country such as South Africa, where industries were developing rapidly, was that the coverage of science and technology, and indeed of all learning, was not necessarily less than in the older, developed countries but was thinly spread. This was because there were fewer specialists in specific fields, and that the resources for the development of comprehensive, in-depth information services were limited. In such circumstances there was the greatest need for information services to reduce the 'technology gap'.

Information explosion

A further complicating factor was the exponential growth (estimated at 15 per cent a year) of scientific and technical publications as a consequence of the increasing expenditure on research and development in the technologically advanced industrialized countries of Western Europe and North America. This clogged the avenues of conventional publication, resulting in a vast proliferation of informal publication of pamphlets and reports lacking, for the most part, appropriate forms of bibliographic control. This so-called 'information explosion' greatly increased the complexities of the tasks confronting centres such as the CSIR which were obliged by their mandate to provide national services in the field of scientific and technical information.

This commitment was stressed by the president of the CSIR, Dr Meiring Naudé, in his presidential address to the Associated Scientific and Technical Societies in 1965 when he said that 'it is perhaps not generally realized that in terms of its Act, the CSIR has very wide and comprehensive responsibilities in the field of scientific and technical information, extending far beyond the needs of its own laboratory organization'.

Library and Information Division

In meeting these commitments the CSIR was fortunate in securing the appointment of Miss Hazel Mews, as head of its Library and Information Division. With her experience in public and industrial libraries in South Africa, and in information and publishing services in Britain, she was well equipped to plan and develop the kind of service envisaged by Dr Schonland.

Under her leadership the Library and Information Division grew into a postgraduate scientific and technological library not only for the use of the Council's staff but also as the nucleus of a central library for science and technology and a national centre for scientific and technical information. This was the concept which formed the cornerstone of the Council's policy and to which it adhered throughout. The basic pattern combining the practices and functions of several types of libraries and bibliographic institutions was in many respects unique at that time.

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An important milestone was reached in 1957 when the Library moved from its Visagie Street premises – which had become so congested that some of the work had to be done on the floor – to a new purpose-designed building on the CSIR site east of Pretoria. However, a certain amount of decentralization was unavoidable, as the National Institute for Personnel Research and the National Institute for Telecommunications Research were in Johannesburg. In addition, for some years a branch library had to be maintained in Visagie Street to serve the laboratories which remained in the old premises and the Bureau of Standards which at about that time was amalgamated with the CSIR. Despite this physical decentralization, procedures were evolved for maintaining a reasonable measure of centralized professional control in the ordering, processing (accession, classification and cataloguing) of publications with the aim of ensuring accessibility to users from outside the CSIR. Thus, of some 24 000 publications issued by the Library in 1953, 3 000 were on loan to outside borrowers.

The dual function of serving as a CSIR library and a national lending library for science and technology was continued in subsequent years. For example, in 1983–84 63 000 publications were issued, including 13 000 to outside borrowers and 3 000 on loan from other libraries, indicating the interdependence of libraries. In addition, subscriptions to journals which are the main source of current scientific and technical information used by research workers, rose from 3 000 titles in 1966 to 5 500 in 1984.

To assist outside borrowers, particularly those without readily available library services, a document delivery service was started in the early 1980s to obtain photocopies of documents (mostly journal articles and conference papers). In 1983–84 some 39 000 documents were obtained for its users and

A national function

The library building at Scientia,
occupied in 1957



the large number of documents supplied-confirmed the need for such a service. Despite considerable growth in the national book stock it is interesting to note that of the 39 000 requests received by this service only 46 per cent could be met from the CSIR's stock and a further 14 per cent from other South African libraries. The remainder had to be obtained from abroad. The extent to which this service had to draw on overseas document sources clearly indicated that the national book stock was still far from adequate to meet the needs of the South African scientific and technical community.

Foreign languages service

Publications in foreign languages were a source of concern, particularly in the 1950s and 1960s. To help research workers, the CSIR library maintained a panel of translators and subscribed to published lists of foreign language translations as well as to the Commonwealth Index of Translations, issued on catalogue cards by the Association of Special Libraries and Information Bureaux (ASLIB) in London. Later a small in-house foreign language information service was set up under Miss G J Kraan. As always, the problem was to cover, with a limited staff, a large number of highly scientific and technical subjects from several foreign languages to meet fluctuating demands. At the height of its activity in the mid-1960s this service was capable of translating from 16 foreign languages. Translations were listed in the monthly *CSIR Library Information and Accessions* and in 1967, for example, 56 copies of such translations were provided to enquirers from South Africa and other countries.

As well as building up the library collection of books, journals, pamphlets and associated services, the Library and Information Division directed its limited resources to the compilation of bibliographic aids.

Periodicals in Southern African Libraries (PISAL)

- As early as 1955 the division assumed responsibility for the arrangement and administration of the science and technology section of the *Catalogue of Union Periodicals* (on cards) which was previously maintained on behalf of the South African Library Association by Mr Percy Freer, then Chief Librarian of the University of the Witwatersrand. This catalogue aimed at providing a comprehensive 'finding list' of the holdings of South African libraries of scientific and technological journals and serial publications (proceedings of societies, etc.). Later under the Information and Research Services the decision was taken to rearrange the entries alphabetically by journal title. This opened the way to the inclusion of titles in the field of the humanities, initially in co-operation with the University of the Witwatersrand and subsequently the University of South Africa. The work on the humanities was first supported by the National Council for Social Research and later its successor, the Human Sciences Research Council, and ultimately the National Library Advisory Council. This combined 'union list' of serial titles became known as *Periodicals in South African Libraries* and later as *Periodicals in Southern Africa Libraries (PISAL)*. In 1970, a separate *PISAL* steering committee was established and the humanities section was transferred from the University of South Africa to the CSIR, although the staff were still employed by the University. From 1974 all *PISAL* staff were CSIR employees. The success of this co-operative effort owed much to the project leaders, Mrs Anne-Marie de Graaf of the CSIR and Miss Elizabeth Hartman of the humanities team, and subsequently Miss Sybil Nicholson, the leader of the combined team.

This mammoth task provided an excellent example of the advantages to be gained from the application of electronic data processing to the compilation and publication of bibliographic aids and guides to sources of information. In 1970 it was decided to stop work on the first edition and proceed directly through the use of computerized procedures, to the production of a complete second edition. By 1973, the second edition had been completed and preparations for the third had begun. At that stage it was decided that, in view of the sharp rise in printing costs, the third edition would be issued in microfiche form only. The use of COM (computer output microfilm) techniques proved far more economical and made it possible to publish revised editions more frequently. From 1979 onwards the cost of maintaining this catalogue was borne by the Department of National Education through the National Library Advisory Council and the funds thus released were used by the CSIR for further development and refinement of the catalogue.

On the recommendation of the National Advisory Council for Librarianship and Information Affairs (successor to the National Library Advisory Council as from 1982), the responsibility for compiling *PISAL* was assigned in principle to the State Library as from April 1984. However, for the time being, the CSIR continued with the actual compilation work.*

In the meantime, progress had been made in the application of electronic data processing as an aid to information storage and retrieval. In 1964 an operational study of library procedures was undertaken and a start made with limited electronic data processing projects (serials records). The long-term objective was to build up a group with appropriate experience in this field who could take advantage of systems being developed in other countries. In 1968, an Information Processing Group headed by Miss N M Lodder was formally established and by 1971 it had:

- Adapted a Canadian system to the computerized compilation of *Periodicals in South African Libraries*.
- Computerized the production of Keyword-in-Context (KWIC) indexes to current literature in the field of water research (on behalf of the National Institute for Water Research), a register of university research projects, and an index to CSIR publications.
- Produced the *South African National Bibliography* (on behalf of the State Library) by means of computerized listing and photocomposing techniques, adapted from those developed for this purpose in West Germany.
- Made a comprehensive survey (on behalf of the National Library Advisory Council) of developments, present and planned, in the application of computers to library and information services in South Africa.
- Undertaken feasibility studies in connection with the provision of services for the selective dissemination of information on a national basis with the aid of magnetic tape data bases (indexes) which had become available from major international abstracting and indexing services.

Electronic data processing

* *PISAL* was to be fully transferred to the State Library in 1986.

- Investigated (on behalf of the National Library Advisory Council) the possibility of using, on a national basis, machine readable library cataloguing records (MARC), a project initiated by the Library of Congress, USA.
- Programmed a computerized system to process data for the *National Register of Research Projects in South Africa* on behalf of the scientific adviser to the Prime Minister and a system for sorting and printing English and Afrikaans technical terms for a dictionary in the field of textile technology.

In 1980 progress was made in the computerization of the CSIR's library operations leading to the adoption of DOBIS running on the existing IBM system via the existing network. In 1981, a program package known as SCIDOC was developed and introduced for separate document collections in the CSIR institutes, in order to make these documents more accessible. The introduction of SCIDOC and of the DOBIS package were in line with a new view of the CSIR library services. Rather than aiming for a greater measure of physical centralization, it was decided that the introduction of computerized CSIR, and national, library networks would make it possible to keep the documents (books and periodicals) closer to the end user while at the same time ensuring that such documents would be easily accessible from anywhere within the CSIR through the use of uniform bibliographic procedures.

Technical Information Service

In the 1960s, technical enquiry services were combined with library reference services to provide industry with technical information. In 1966 Dr R van Houten of the Techno-Economics Group was assigned the task of making a survey of the flow of information to industry in South Africa, with particular reference to the factors affecting technical innovation, particularly electronic instrumentation. It was found that small and medium-sized firms were in need of assistance, particularly in locating sources of information on practical problems peripheral to their main line of business. On the basis of these findings, a Technical Information Service (TIS) was started in 1968 under Dr van Houten to provide a field liaison service and to disseminate technical information to such firms. This was done by means of factory visits, the handling of technical enquiries not dealt with by CSIR institutes, and by organizing symposia and conferences. In 1970 a start was made with the provision of a technical current awareness service (CAS), under Mr B J Zulch, aimed particularly but not exclusively at the metal-working industries. This field service was extended by the appointment of technical liaison officers in Bellville, Port Elizabeth and Durban. These three regional offices were equipped with their own teletype terminals which enabled them to access bibliographic data bases directly. In 1982, a fourth regional office was established in Johannesburg with a view to providing a more direct service to industry on the Reef and closer liaison with bodies like the Steel and Engineering Industries Federation of South Africa.

Computerized information services

Following extensive preparatory work, the 'South African Selective Dissemination of Information Service' (SASDI), under the guidance of Mr A G Brunt, became operational in 1973. In 1976, a 'South African Retrospective Information System' (SARIS), an on-line retrospective literature searching

service, was started following experiments with such a service in the previous years. An information service in the field of water was provided by the South African Water Information Centre (SAWIC) in parallel with SASDI and SARIS under contract to the Water Research Commission. The centre took over the responsibility of compiling Current Literature on Water, the name of which was later changed to WATERLIT. In 1980, the computerized bibliographic data base WATERLIT was included in the data base collection of the Systems Development Corporation in the USA and from then onwards could be accessed worldwide. This was rightly regarded as something of a breakthrough. A patent literature information service of particular interest to industry was introduced in 1982 and early in 1984 the South African Energy Information System, financed by the Department of Mineral and Energy Affairs, became operational.

Although the requirements of the CSIR's national research laboratories and institutes were of immediate concern in the development of all these services, they did not in practice obscure the main objective of providing national library and information services. Accordingly, as early as 1955, an advisory committee on library and related matters was appointed by the CSIR with a view to planning and developing these services in close consultation with the South African library profession and the main user organizations. This committee was reconstituted and renamed several times, in 1969 becoming a committee of the CSIR Council known as the Advisory Committee on Information and Documentation (ACID). From 1963 onwards specialist advisers were appointed to carry out reviews of specific activities for consideration by the committee.

Close association was maintained with the National Library Advisory Council set up by the Minister of National Education in 1967 to give effect to the recommendations of the National Conference of Library Authorities held in Pretoria in 1962. In view of the policy adopted by the Advisory Council of building up the national book stock through co-ordinated decentralization of collections in the main national, provincial, municipal, academic and special libraries, the main concern of the CSIR was to develop its library lending and information services in such a way as to fall in with this concept. IRS staff members including the director, were actively involved in several committees and working groups of the Library Advisory Council, mainly in connection with bibliographic services, information retrieval, machine readable cataloguing, a computerized cataloguing network, and a national research programme. In 1982 the Advisory Council was superseded by the National Advisory Council for Librarianship and Information Science, under the chairmanship of Dr E N van Deventer, a deputy president of the CSIR.

In addition to its involvement with *Periodicals in Southern African Libraries*, the CSIR's Centre for Scientific and Technical Information, under the auspices of the National Library Advisory Council, played a leading role in investigations relating to the possibility of establishing a computerized library network in South Africa. Following an extensive feasibility study, recommendations were made on an appropriate network architecture and the most suitable software for this purpose. The study ultimately resulted

National co-operation

*International
co-operation –
computerized
abstracting and
indexing services*

in the establishment of the South African Bibliographic and Information Network (SABINET).

The developments which have been described reflect the rapid advances in information technology during the 1960s and 1970s, particularly in Western Europe and North America. During the 1950s the Russians were undoubtedly ahead in the development of national scientific and information services. For example, it was claimed that VINITI, the central information service of the USSR Academy of Sciences, had a staff of 2 000 with 20 000 associates and many regional centres. However, when in 1957 (during the International Geophysical Year) the Russians stole a march on the Americans with the successful launching of the first artificial earth satellite, Sputnik I, the USA was spurred to action. The US National Science Foundation set up the Office of Scientific Information Services which liberally funded and co-ordinated innovative projects, particularly those related to the development of more effective abstracting and indexing services for various fields of science and technology. The pace was set by the National Library of Medicine which developed computerized procedures for the production of *Index Medicus*, and then made available to other centres the magnetic tapes generated in this procedure to conduct computerized literature searches. This service, known as MEDLARS, was a trend-setter and was soon followed by others, such as the Chemical Abstracts Service (CAS), Biological Sciences Information Service (BIOSIS) and Engineering Index (EI).

These initiatives were matched by similar developments in other Western countries. For example, the British Department of Education and Science set up the Office of Scientific and Technical Information (OSTI) which fostered and funded similar developments in the library and information field. Of particular significance was the negotiation of reciprocal agreements between British, West German and American agencies in terms of which the indexing of all chemical publications originating in the three countries was concentrated in the data bases produced and marketed by the Chemical Abstracts Service, Columbus, Ohio, USA. In terms of a similar arrangement, physics and electronics publications were indexed in a computerized data base produced and marketed by INSPEC, under the auspices of the British Institution of Electrical Engineers. Before long there was a proliferation of bibliographic and numerical data bases, all with different characteristics and of varying quality. A measure of order in this situation was achieved by the establishment of data base 'brokers' which provided a service through which selected data bases could be accessed for computer searches through intercontinental telecommunications networks.

Throughout this turmoil of rapid development in the field of information technology the Canadian Institute for Scientific and Technical Information pioneered the application of computer techniques to the development of library and information systems suited to the needs of smaller industrial countries. The CSIR was fortunate in being able to take advantage of these systems, for example, in the computerized production of *Periodicals in South African Libraries (PISAL)*, and in launching the computerized South African Selective Dissemination of Information Service (SASDI).

In a period of rapid scientific and technological development, formal publication is liable to lag behind practice by as much as three years. It is important, therefore, to maintain personal contacts to evaluate these new developments and their relevance to local circumstances. Membership of international, non-governmental professional organizations, attendance at their conferences and participation in their activities therefore played a crucial role. Thus, from 1958, the CSIR, through its Information and Research Services, was the 'national member' of the International Federation for Documentation (FID), from 1974 of the Abstracting Board of the International Council of Scientific Unions (ICSU/AB)* and, from 1984, of the International Council of Scientific Union's Committee on Data in Science and Technology (CODATA). In addition, the CSIR became an institutional member of the International Federation of Library Associations (IFLA) and several other international bodies in the fields of librarianship and information. Specialists from overseas were also invited to South Africa for consultation and to participate in local conferences. For example, in 1978 a conference on computerization of library information services and in 1980 a conference on the education and training of information workers were organized by the CSIR.

In 1975 the CSIR library and all the information services were grouped together to form a national Centre for Scientific and Technical Information (CSTI). Although this development gave recognition to the national function of the CSIR library and information services, the centre continued to operate within the framework of the Information and Research Services. However, because of the further growth and increasing sophistication of these services, the centre in 1980 became a separate national institute and its head, Dr R van Houten, an electronics engineer with a doctorate in business administration, was promoted to the rank of director. At that time, the CSTI comprised, broadly speaking, two operational branches, namely the Library Services Group (headed by Mrs J I Snyman and succeeded by Miss N M Lodder in 1984) and the Information Services Group (headed by Mr A G Brunt), as well as documentation, foreign language and administrative support services.

The centre experienced sustained growth in the demand for its information services. By 1980 well over 1 500 computerized retrospective literature searches a year were being carried out in the fields of science and technology in general, plus another 400 on subjects related to water. Searches were being undertaken from computer terminals at the CSIR in Pretoria as well as in regional offices in Bellville, Port Elizabeth and Durban, providing access, by way of long-distance telephone links, to bibliographic data bases in North America and Europe and to the centre's own data bases.

A similar growth was experienced in the centre's current literature awareness services. By 1980 the number of subscriber interest profiles for the computerized alerting service had increased to 1 700 in the field of science and technology (SASDI), another 180 in the field of water, and over 1 000 for alerting services tailored specifically to the needs of industry. In 1984-85



Dr R van Houten
Appointed Director, Centre for
Scientific and Technical
Information, in 1980
(Chief Director 1983-1984)

*Centre for Scientific
and Technical
Information*

* Later, International Council for Scientific and Technical Information.



Mr V A Shaw
Director (later Chief Director),
Centre for Computing Services,
1980–1984
Appointed Chief Director, National
Institute for Informatics, in 1984

direct access by means of a high-resolution graphic terminal was gained to the on-line molecular structure information service provided by the Chemical Abstracts Service in the USA. This service was of great importance to the chemical industry and the chemical research community. A start had also been made with the provision of searches from a numeric data base in the field of crystallography. Direct contact with industry was maintained by some 1 400 field liaison visits a year to industry by the centre's staff.

In these and other ways, the CSIR fulfilled its original statutory mandate to 'establish and control facilities for the collection and dissemination of scientific and technical information'. Swift access to worldwide sources of published scientific and technical information, as well as assistance to other agencies in the application of new technology, could be provided.

In recognition of the increasing importance and future interdependence of information science and computer technology, the CSIR decided, after the retirement of Dr van Houten in 1984, to amalgamate the Centre for Scientific and Technical Information and the CSIR's Centre for Computing Services to form the National Institute for Informatics with Mr V A Shaw as chief director.

Scientific and technical communication

As the CSIR developed, the need arose to inform not only industry, public bodies, universities and the scientific and technical community of its facilities and services, but also to promote public awareness of the contribution of science and technology to the development of South Africa. This was one of the functions assigned to the Liaison Division in the 1950s, which was later incorporated in the more broadly based Information and Research Services of the CSIR.

Early efforts towards informing the general public about science and its role in promoting general welfare included:

- The staging of exhibits at major industrial and other exhibitions, notably the Van Riebeeck Festival Fair in the Hall of Science in Cape Town in April 1952.
- Arranging annual 'open days' to which the public was invited to visit the new laboratories of the CSIR at Scientia, east of Pretoria – major undertakings attracting thousands of visitors.
- The production of documentary films of the research activities of the CSIR for showing on the open cinema circuits; these were of a high standard and won several international awards.
- The production of illustrated brochures on the activities of the CSIR as a whole.

As the CSIR organization grew and increased in complexity, however, these comprehensive presentations necessarily became too generalized and less rewarding in terms of the demands on the time of research staff and production costs. Accordingly, they gave way to specific programmes arranged for special interest groups and particularly for schoolchildren.

These programmes were supplemented by sophisticated audiovisual presentations.

As a 'national research council', the CSIR came to accept that it had an obligation to promote a better public understanding of science nationally and internationally and of the role of organized research and development in contributing to the achievement of national goals such as economic growth for job creation, improved living conditions, conservation of the natural environment and generally a better quality of life for all. This was a commitment which posed many problems in the field of communication and required a highly professional approach.

Not the least of these problems was the need to dispel the public image of the scientist, as a rather aloof individual unconcerned with human values, tampering with nature and lacking an appreciation of everyday practical problems. In addition, the scientists failed to comprehend the imperatives of the mass media. Recognizing that the advance of knowledge is a step-by-step process, that the complete solution or so-called spectacular breakthrough is rare indeed, they were understandably wary of sensationalism and preferred to report their own work in scientific and technical journals or at conferences and symposia for evaluation by their peers. Owing to lack of appropriate training, scientists and engineers are in any case not noted for their skills as communicators.

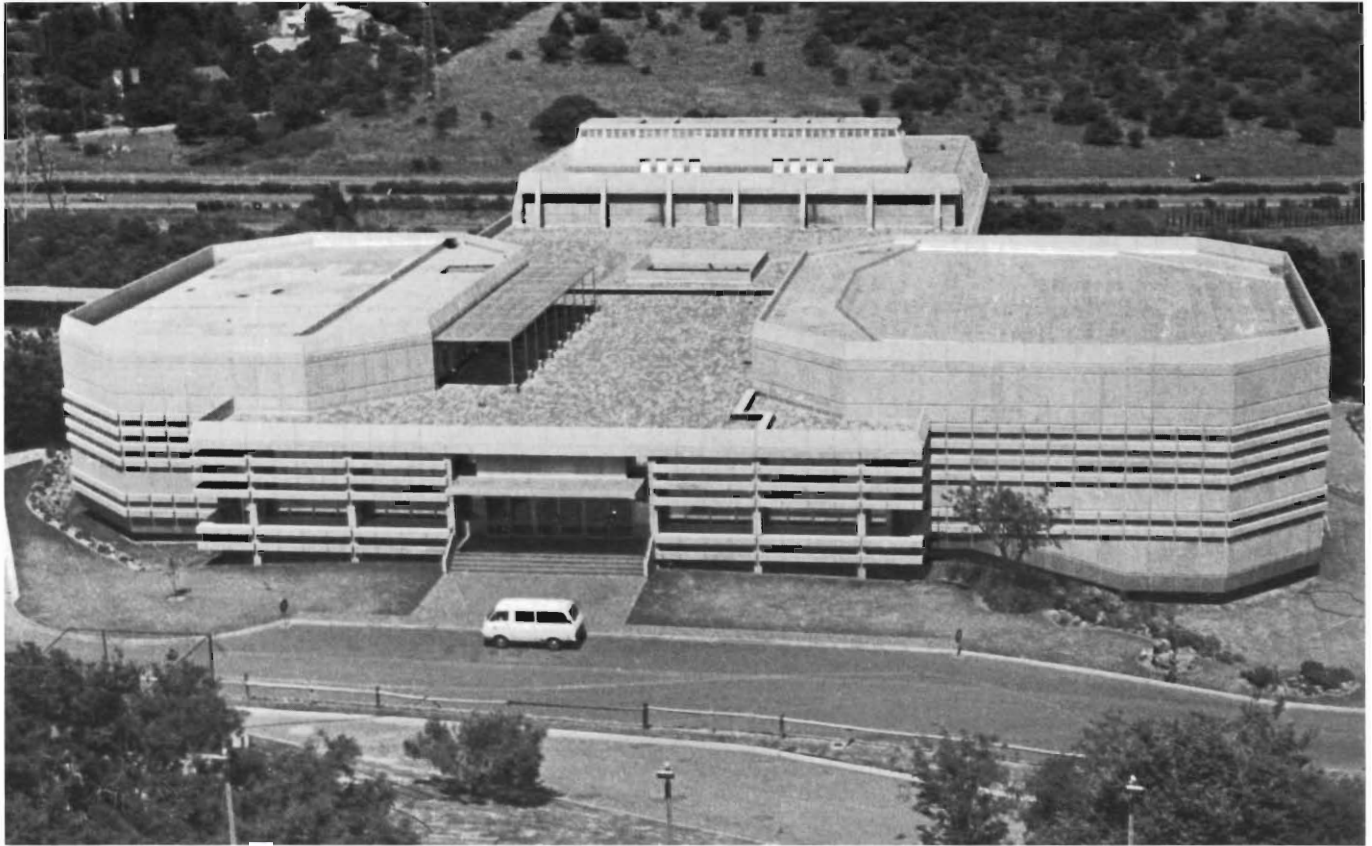
To bridge the communication gap and to promote a better understanding between the media and research workers, a small Publicity Division was developed. The activities of this division included

- a quarterly journal, *Scientiae*, publishing semi-popular articles (mainly on the activities of the CSIR) aimed at a readership broadly defined as the 'non-specialist' with an interest in science;
- press releases, press conferences, and the promotion of personal contact with research staff;
- documentary films and TV programmes, contracted out to professional agencies, as well as audiovisual programmes (slide shows) to inform visitors and guests about the CSIR's organization and activities;
- co-operation with schools, the education authorities and other groups in the presentation of science to schoolchildren;
- a weekly staff newspaper *Sciendaba* featuring current CSIR news.

The reception of visitors to the CSIR and, in the case of foreign guests, the arrangement of itineraries, travel, accommodation, and so on were handled by a visitors' office. In 1962 a symposium secretariat was formed to organize one-day industrial symposia, with a view to promoting personal contact between industrialists and the staff of CSIR research institutes. Later its scope was extended to assisting CSIR institutes and other professional groups in the organizing of major conferences and symposia. Because of the high professional standards the secretariat maintained its services were much sought after and by 1980 it had been involved in the organization of some 400 major national and international conferences and symposia in South Africa.

Promoting public understanding of science

Visitors' office and symposium secretariat



The CSIR Conference Centre, opened in October 1977

*CSIR Conference
Centre*

Until 1977 one of the limiting factors had always been the lack of a suitable venue for meetings, and conferences often had to be held far from the main centre of the CSIR in premises lacking proper facilities. These difficulties were overcome when a modern, well-equipped conference centre was opened at the CSIR in October 1977. With its auditoria (seating 450, 150 and 100 people respectively) air-conditioning, equipment for simultaneous interpreting, audiovisual presentations and the like, offices and other facilities for the administration of meetings, space for registration and temporary exhibits and a restaurant, the centre provided adequate facilities for national and international conferences.

Management of the centre was entrusted to the Information and Research Services through which the CSIR was now able to offer a comprehensive conference service not only to its own institutes but also to outside organizations. In 1979 about 30 500 people attended meetings in the centre, indicating that this facility met a real need. In the same year simultaneous interpreting from French, German, Spanish and Afrikaans was provided on 50 days.

*Publishing and
graphic arts*

Although it was the policy of the CSIR for the results of research to be published in scientific and technical journals of international standing, it was inevitable that its research institutes should generate a variety of reports for special purposes. To cope with this kind of semi-formal publication, characterized by short runs and multiple illustrations, a Graphic Arts Division was set up within the Technical Services Department. In addition, a small Publishing Division was developed within the Information and Research Services. This division, in addition to providing a referral service on matters such as language usage and documentation standards, also provided an editorial advisory service. Prime responsibilities were the compilation and publication of –

- the CSIR's Annual Reports (a statutory requirement);
- *CSIR Publications* – a quarterly list of articles and reports published under the auspices of the CSIR, with keyword and author indexes; this was backed-up by a publications distribution service which maintained a publication store to provide copies on demand and a publications archive;
- a directory of the various divisions and services of the CSIR, updated regularly, under the title *The CSIR – its organization and activities*;
- a list of conferences, symposia, etc., due to be held during the ensuing six months, entitled *Calendar of scientific and technical meetings in South Africa*;
- biennial directories: *Scientific research organizations in South Africa* (guide to government organizations, statutory bodies and industrial concerns with research laboratories); *Scientific and technical societies in South Africa* (their aims and objects, membership, publications, etc.), and *Scientific and technical periodicals published in South Africa* (fields covered, subscription rates, etc.).

An associated 'special project' was concerned with the input from the CSIR's national research institutes to the development of Afrikaans technical terminology. A *Textile Dictionary (English-Afrikaans; Afrikaans-English)*, compiled by the CSIR in collaboration with other bodies, was published in 1973 and revised in 1978. A computerized system was used and, with the experience gained, the CSIR played an important part in starting and contributing to a computerized national terminology bank under the auspices of the Terminology Bureau of the Department of National Education. Through the leader of this project, Dr D F Louw, the CSIR was also represented on the Co-ordinating Terminology Board. Under the chairmanship of the Secretary for National Education, this board was given responsibility for the co-ordination of all aspects of terminological research in South Africa, the establishment of national norms and policies for the preparation of terminology lists and dictionaries, and for liaison with bodies in other countries involved in terminological research.

Among those who played a leading part in the communication activities of the Information and Research Services was Mr D R Masson, who was responsible for the publishing and publicity services in the 1950s. When he left in 1958 for a second term as head of the CSIR's scientific liaison office in Washington DC, USA, Mr L R Dickson took over responsibility for the publishing and related editorial activities and Mr A C Papageorge took charge of publicity. When they left, Mr J F Herbst became head of the Publishing and Publicity Group – a post he held with distinction from 1969 to 1983. In this group leading roles were played by Mr P Pretorius (publishing) and Mr G W B Stoop (publicity). In the field of 'person-to-person' communication, well-known personalities were Mr D R Maude (public relations), Mrs Maura de Havilland (who developed the symposium secretariat) and Mr K R McCusker, former assistant manager of the Technical Services Department, who was responsible for commissioning the Conference Centre and co-ordinating these activities within the IRS. On his retirement, he was succeeded by Mr R K Newman.



Mr J F Herbst
Head, Publishing and Publicity
Group 1969-1983

PART 3

The CSIR as a National Research Organization

The name *Council for Scientific and Industrial Research* does not necessarily convey the image of a body that controls and manages its own research establishment. Nevertheless, it is clear that from the outset, it was intended that the Council should set up and run its own research organization in addition to the broader advisory, co-ordinating and funding functions described in the preceding chapters. The adoption of this title must be attributed to the general acceptance of the prevailing concept of the 'research council' which had evolved in Britain over the previous 30 years.

The clauses in the Research Council Act (as amended) which refer specifically to the establishment of the CSIR as a 'national research organization' are the following:

- 4(1)(b) To seek new knowledge through research, investigations and tests in such a manner as it may deem advisable, mainly with the object of improving technical processes, methods and services and industrial products, and of developing processes and methods which may promote the expansion of existing, or the establishment of new industries or the better utilization of raw materials and waste products.
 - (c) To undertake or aid scientific research in connection with such matters as the Minister may refer to it for investigation.
 - (d) To provide and control facilities for the testing and calibration of precision instruments, gauges and apparatus, the determination of their degree of accuracy and the issue of certificates in regard thereto.
 - (e) To provide and control facilities for research in connection with standardization in industry and commerce.
 - (f) To maintain primary scientific standards of physical quantities for the Republic and to provide for their comparison with international standards from time to time.
- 4(3)(a)(i) With the approval of the Minister, purchase or otherwise acquire, or hold, alienate, hire or let immovable property, and establish laboratories or other facilities.

The CSIR records indicate that there was some soul-searching about the need for national research institutes and the form in which they should be developed. However, Dr Schonland appears to have had no doubt in his own mind about the need for a National Physical Laboratory, modelled on the National Physical Laboratory at Teddington in Britain and the National Bureau of Standards in Washington DC. These two bodies and others like them in Europe had existed for some 50 years and their essential role in maintaining national and international standards of measurement had come to be recognized as indispensable to the development of science and industry.

He also appears to have been fully convinced of the need for a National Building Research Institute, particularly in finding solutions to the problems of overcoming the vast backlog in urban housing for the black population which was undergoing a process of rapid urbanization. There were, however, some initial doubts about chemical research, possibly because the major chemical industries world-wide were far more self-sufficient in research than any other industry. However, at its first meeting, the Council decided in favour of a National Chemical Research Laboratory to focus particularly on longer-term basic research.

The intentions of the CSIR Council on the establishment of national laboratories were summed up in its first policy statement *Objects and Policy of the CSIR – an initial statement*, issued in December 1945. In this document, although the need for encouraging industrial research by individual firms and by industrial research associations was acknowledged, it was emphasized that industrial research in both these forms was bound to be incomplete without back-up from national laboratories. The argument ran as follows:

'It is inevitable that, because it is so closely associated with factory and works practice, such industrial research will be for the most part of a short-range and extremely practical type.

'There is need, therefore, for a small number of National Research Laboratories to take over from industry, sometimes with its financial aid, the long-range type of investigation. Such investigations are not always successful in their outcome and for this reason only the more wealthy industries can afford to undertake them in their own laboratories. They are, however, of great importance to the nation as a whole.

'In addition these national laboratories would provide specialist facilities and scientific men to serve those industrial research workers who need advice and assistance on problems beyond their ability or means. For example, few industrial firms can afford the equipment and specialist staff required for electron microscopy or X-ray diffraction, though many of our industries already have need of these devices from time to time.

'As institutions lying midway between the practical research laboratories required by industry and the academic research conducted in university departments, these national laboratories would also provide an important link between the two and place the industrialist in closer touch with specialists of a still more academic type in universities.

'Finally, and this is perhaps their most important function, these national laboratories would provide a reservoir and a training ground for the most gifted of our scientific men and women who, after a period of training in research, can move into positions in industry or in universities without having to concentrate for many years on teaching.

'The Council proposes to establish immediately a National Physical Laboratory, a National Chemical Research Laboratory and a National Building Research Institute.'

Although not referred to specifically in *Objects and Policy of the CSIR* (see p. 13), the Council at its first meeting in October 1945 decided to proceed

National research laboratories and institutes

*Telecommunications
and personnel
research*

immediately with two projects proposed by Dr Schonland. Both stemmed from wartime developments and were to be exceptionally successful.

The first concerned telecommunications (radio and radar). In view of the urgent needs of the Departments of Defence, Transport, Posts and Telegraphs and their associated services for ionospheric and other relevant data, it was arranged with the Department of Defence for a small but expert team of volunteer service personnel to be made available before their demobilization to establish these services as quickly as possible, on the understanding that the staff concerned would be transferred to the CSIR on 1 January 1946. The Council agreed that telecommunications should be handled as a 'project item', detached from the National Physical Laboratory and, for technical and other reasons, associated with the Department of Electrical Engineering of the University of the Witwatersrand.

The other 'project item' was a bureau for the co-ordination and development of research in personnel selection and general industrial psychology. In this field, the success of the team led by Dr S Biesheuvel, head of the aptitude tests section of the South African Air Force, had been widely acclaimed. As it was recognized that the procedures developed for the selection and classification of personnel for the armed services could be adapted to the work situation in civilian life, it was decided that a nucleus of the team, with its records, should be kept together. For this purpose a temporary National Bureau for Personnel Research was set up within the framework of the CSIR.

Thus in the short space of two years in the difficult post-war period, Dr Schonland established and built up the national research organization component of the CSIR – the National Physical Laboratory, National Chemical Research Laboratory, National Building Research Institute, Telecommunications Research Laboratory and National Bureau for Personnel Research (which soon became the National Institute for Personnel Research). They formed the hard core of the CSIR's research organization in those early days and set the pattern from which many other activities were to grow in the years to come.

These national laboratories and associated services were initially housed in temporary accommodation in Visagie Street, Pretoria, in buildings which had been erected for the munitions section of the South African Mint during the war. For some 20 years they provided temporary accommodation for the CSIR, the S A Bureau of Standards and the Trigonometrical Survey. The premises were far from ideal, having been designed for a very different purpose, but they were adapted without major structural alterations and served remarkably well during the initial settling down period.

With the acquisition of an excellent site to the east of Pretoria in 1948, the planning, design and erection of suitable buildings went forward in earnest (see pp. 18, 19).

Advisory committees

Dr Schonland felt strongly that the staff of the national laboratories should have as close an association as possible with research workers in other organizations, particularly the universities. With this in mind he introduced a system of research advisory committees.



The CSIR headquarters in Visagie Street, Pretoria, in the early years. These buildings housed the laboratories and associated services until permanent accommodation became available at the Scientia site to the east of Pretoria.

As the research institutes became larger and more complex, the effectiveness of these committees was to some extent diminished. To counteract this, specialist advisers were appointed who spent some time each year in the laboratories getting an in-depth picture of research programmes and projects and reporting on their findings to the advisory committees. A limiting factor was that in most cases the advisory committees had no responsibilities for the allocation of funds, although this did not apply to project 'steering committees' for sponsored projects.

The basic philosophy of the Council was that industry should be induced to accept research as one of the basic costs of production and not something that could be left to the Government. Accordingly, it was decided that all research for individual firms and other bodies should be undertaken on a contract basis.

This concept of sponsored or contract research originated in the United States. The Battelle Memorial Foundation, Columbus, Ohio, introduced the idea of undertaking problem-solving investigations at an agreed price. This yielded sufficient revenue to sustain longer-term more basic studies to build up and maintain expertise in specific fields. The Mellon Institute in Pittsburgh evolved the concept of industrial research fellowships through which major, high-technology industrial corporations maintained longer-term basic fellowship programmes in designated fields. During the war and in the immediate post-war years, a number of similar 'non-profit' institutions sprung up in different parts of the USA and aggressively marketed their services.

The CSIR was, as far as is known, the first government-funded research organization to adopt the concept of contract research. The Council's intention was to provide a means by which industrial firms could be encouraged to become involved in research geared to their own interests, without long-term commitments in respect of highly qualified staff and capital outlays for expensive equipment. In practice the CSIR institutes

Contract research



Dr S M Naudé
Director, National Physical
Laboratory, 1946–1950

quoted for and recovered the full cost of the work, or a portion of it, depending on the general level of applicability and the proprietary interests of the sponsor. There were, of course, many snags, such as those involving ownership of patent rights and confidentiality.

As it turned out the main source of contract income was the public sector – central, provincial and local government, and other public bodies. From the mid-1950s onwards, contract income of the CSIR's national institutes fluctuated between 30 and 35 per cent of the total annual budget. Of this income, possibly nine or 10 per cent came from the 'business sector'. While this was disappointing, it was perhaps understandable in a developing country characterized by a limited internal market. Nevertheless, the system of contract research adopted by the CSIR proved to be the mainspring of the growth of its national research institutes, in other words, of the development of the CSIR as a 'national research organization'.

Physics and related sciences and technologies

PHYSICS RESEARCH

At its first meeting held in Pretoria on 8 and 9 October 1945, the CSIR Council agreed to Dr Schonland's proposal to proceed with the establishment of a National Physical Laboratory without delay. Soon thereafter Dr S M Naudé, at that time professor of physics at the University of Stellenbosch, was offered the post of director of the proposed laboratory. He accepted and assumed duty in Pretoria on 1 January 1946.

It was agreed that the laboratory should be built up by appointing a few senior staff members immediately and that the rest of the staff should be recruited from young MSc graduates from South African universities who would be sent overseas for further training. In accordance with this decision, Dr E C Halliday of the Department of Physics, University of the Witwatersrand, was appointed for 'general physics' and Dr R Guelke of the Department of Electrical Engineering, University of Cape Town, for 'electricity'. They joined the CSIR on 1 February 1946.

The following month Naudé and Guelke visited Britain, the United States and Canada to study developments in organizations with similar objectives, such as the National Physical Laboratory at Teddington, England, the National Bureau of Standards in Washington DC, the National Research Council in Ottawa, as well as leading universities in those countries. On their return in August, Naudé formulated plans and drew up a budget for the future development of the National Physical Laboratory (NPL).

Among the early appointments to the research staff were Dr E J Marais, initially for geophysics but soon transferred to optics; Mr S C Mossop for heat; Dr J N van Niekerk for X-ray crystallography; Dr A Strasheim for spectrochemistry; Dr S J du Toit for radioactivity; and in the field of electricity Dr O Brune for electrical standards; Mr J P A Lochner for acoustics and Mr J C R Heydenrych for light current electrical engineering. They were sent overseas in relays for advanced training.



Dr A J A Roux
Director, National Physical
Laboratory, 1952–1955

When Naudé was appointed vice-president of the CSIR in 1950, Brune served as acting director until 1952 when Dr A J A Roux, head of the Functional Efficiency Division of the National Building Research Institute, was appointed director of the NPL and head of a new Mechanical Engineering Research Unit. In 1955 this unit became a National Research Institute of which Roux became the director and Dr Marais took over his post as director of the NPL. He, in turn, was appointed a vice-president in 1961 and was succeeded by Dr Strasheim, who headed the laboratory until his retirement in 1982. Dr J S V van Zijl, former head of the Geophysics Division, who had left the CSIR to join the mining industry, returned to take over as chief director. The varied backgrounds of the incumbents of this key position strikingly illustrate the diversity of the specialized aspects of physics which is the science primarily concerned with probing and understanding the nature of matter, physical processes, precise measurement and analysis - basic to all other fields of science and technology.

From the 1950s onwards physics has been characterized by the development and application of instrumentation of increasing complexity and effectiveness in extending the capabilities of the scientist to observe and to measure the composition and nature of matter in ever increasing detail. To the chemist, the materials scientist and the biologist, these are tools to be used in the study of the transformation of matter in chemical reaction, of the behaviour of compound materials in different conditions of treatment and use, or of the processes of life itself in the study of the living cell. The research worker in physics, however, requires not only a basic understanding of the physical principles involved in the efficient development, application and refinement of these instrumental techniques but must also acquire special manipulative skills and expertise to use them. An appreciation of the interests of workers in related fields is of fundamental importance. Physicists need the back-up of technical experts in fields such as instrument making and vacuum technology, electrotechnology and glass-blowing in order to develop, maintain, modify and adapt this highly sophisticated equipment.

To meet this requirement, Naudé insisted that a strong workshop facility be established to help to build up the NPL and at Schonland's request he assumed responsibility for a central workshop for the whole CSIR. He maintained that key staff, such as qualified and experienced instrument-makers and glass-blowers, should be recruited from overseas as he believed that the necessary skills were at that stage not available.

During those early years, the staff who formed the nucleus of the Central Workshop played a particularly important supporting role. Because of the inadequacy and unsuitability of laboratory accommodation and the slow delivery of specialized equipment, improvisation was the order of the day. Among the early successes of the NPL were the development of some ingenious devices for measurements of an unusual kind. Following are some examples:

- The National Institute for Personnel Research (NIPR) was developing aptitude tests, one of them for the operation of a sewing machine in a clothing factory. They brought the problem of the design of such a test to



Dr E J Marais
Director, National Physical
Laboratory, 1955–1961



Dr A Strasheim
Director, National Physical
Research Laboratory, 1962–1982



Dr J S V van Zijl
Appointed Chief Director,
National Physical Research
Laboratory, in 1983

the NPL. It was suggested that a suitable test would be a machine which exposed an upward moving irregularly curved black line on a white background to pass under a pointer which could be moved from left to right on a sliding carriage. A photocell indicated each failure to keep the pointer above the black line and the number of such incidents formed a measure of success in controlling a sewing activity. The NPL produced a suggested design of such an instrument and co-operated with the workshop in the production of a working prototype which was then handed over to the NIPR for trials.

- In a similar manner, when the CSIR's Applied Physiology Research Unit (a CSIR-supported medical research unit) wished to find a reliable way of measuring the surface area of the human body (during physiological studies of heat tolerance of mine workers in the hot, humid conditions encountered underground) the problem was brought to the NPL. After studying earlier attempts to solve this problem it was decided that as heat and light were both forms of radiant energy, the absorption of light could be used to measure the absorption of heat. For this purpose the NPL proposed the construction of an octagonal chamber, painted white on the inner surface and flooded with light from eight electric lamps. This was designed and built in close collaboration with the Central Workshops. An experimental subject was painted all over with water soluble black paint (to form a highly absorbent surface) and stood inside the octagon. Before he entered the octagon a round window in the wall showed brightly illuminated. When the subject entered the octagon the brightness of the window dropped significantly and a measure of the fall in intensity gave a measure of the surface area of the subject's body. This apparatus, called a 'photodermo planimeter', was most successful and was copied in other countries.
- A borehole logging device was developed for use by the Geological Survey in measuring the temperature and radioactivity of layers of rock down to depths of 2 500 m (8 000 ft) in prospecting boreholes 50 mm (2 ins) in diameter. Although similar equipment was available in the USA, this instrument, connected to electrical recording apparatus at the surface by means of a single strand of insulated wire by which it was lowered, proved to be superior for South African requirements.
- Another early successful example of the excellent co-operation that existed between the physicists and the instrument designer and technician was the direct reading spectrometer built in 1950–51. Whereas optical spectra were usually recorded on photographic plates, the development of the photomultiplier vacuum tubes enabled the direct measurement of spectral line intensities. Because of the important industrial potential of direct reading spectrometers a versatile direct reading attachment was developed by Dr A Strasheim and built by the Central Workshops. This enabled pioneer work in industrial analytical spectroscopy to be done at the NPL and played an important role in the use of spectroscopic methods of analysis in industry and agriculture during later years.

These are good illustrations of the versatility and ingenuity which are characteristic of scientists working under adverse circumstances. All the

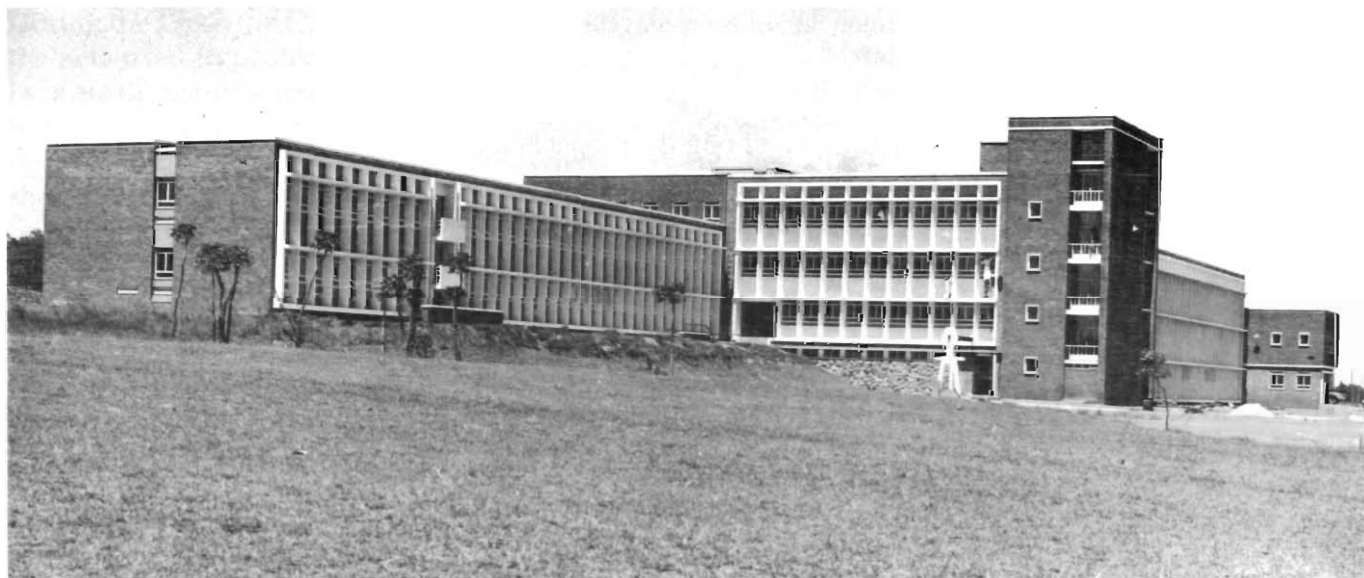
while, however, detailed attention was being given to the planning and equipment of the various sections and divisions of the new laboratory. Precise equipment needs a building designed for it, and the new building which was occupied in 1957 – the second major institute building to be erected at Scientia – opened new horizons for the research staff.

In the same year the NPL's name was changed to the National Physical Research Laboratory (NPRL). This was intended to emphasize the role of the laboratory in contributing to the advancement of knowledge and the solution of practical problems in fields with facets which were not purely physical in nature. It also gave expression to the intention of the laboratory to seek closer collaboration not only with other research laboratories and institutes of the CSIR, but also with universities and other research organizations.

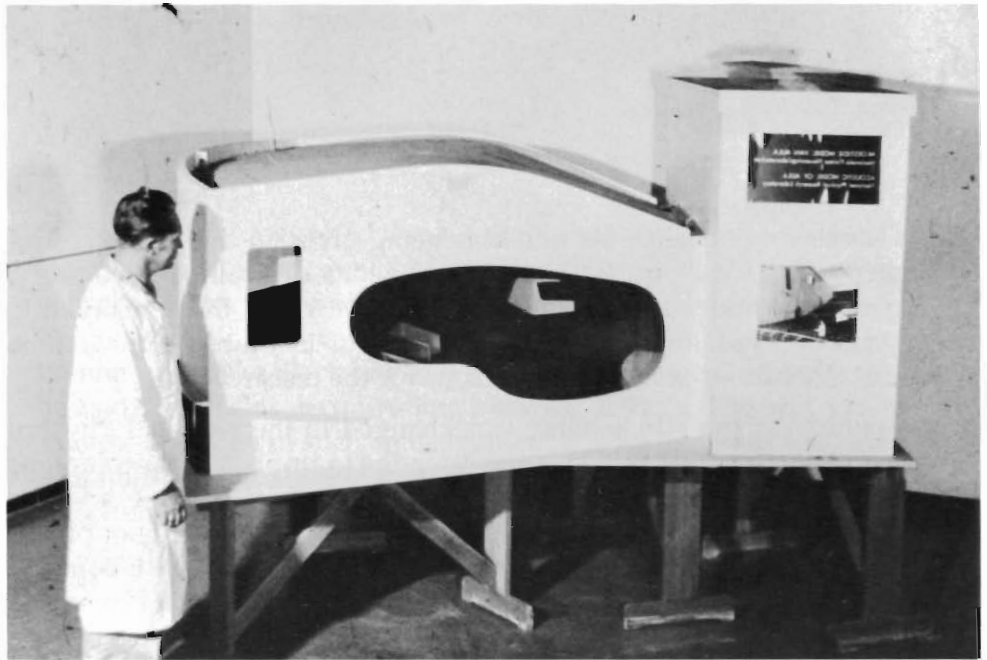
By that time strong research groups had been built up with up to 10 years' experience to provide a focal point for the development of physical science in South Africa. They included nuclear physics (theoretical and experimental), applied radioactivity and radiation; solid state and high pressure physics; physics of matter; electron microscopy, with the emphasis on plastic deformation of metals; X-ray diffraction, crystallography and X-ray fluorescence techniques; spectrochemistry in a variety of applications (including trace elements in plant material, and as an analytical and control technique in the minerals and metals industry); spectroscopy and optics; physical standards (including calibration of equipment and testing of materials); geophysics (including geochronology, palaeomagnetism and seismology); natural isotopes (originally set up for radio-carbon dating methods); physical oceanography; atmospheric physics; acoustics (including ultrasonics); electrotechnology (including computational hardware); and mathematics (including computational mathematics, mathematical statistics, applied statistics and biometrics).

*Scope of research
and facilities*

Building for the National Physical Research Laboratory at Scientia, occupied in 1957.



This scaled-down model of the Aula at the University of Pretoria was used to study and improve the acoustical properties of the auditorium.



*Physics – a seed-bed
for separate institutes*

From the laboratory's inception until about 1960 the emphasis was on the building up of expertise in these fields. Over the next 25 years, however, as these activities grew and developed, many of them were hived off to form separate institutes, in some cases combined with related activities in other CSIR research institutes. They were the National Mechanical Engineering Research Institute in 1955 (p. 160), the National Research Institute for Mathematical Sciences in 1961 (p. 147), the National Electrical Engineering Research Institute in 1971 (p. 153), the National Research Institute for Oceanology in 1974 (p. 161), the Centre for Computing Services in 1979 (p. 152), the National Accelerator Centre in 1977 (p. 146), and the National Institute for Materials Research in 1983 (p. 140).

With the formation of the National Institute for Materials Research and the consequent exision of the activities of the Materials Science Group, the remaining divisions of the NPRL were reorganized in 1984 into two main research groups, namely general physics (acoustics, national measuring standards and metrology, and optical sciences) and earth and atmospheric sciences (atmospheric sciences, geochronology, geophysics and natural isotopes). The activities of each of these divisions are reviewed here.

Acoustics

The NPRL was among the pioneers in research in acoustics and its studies included the acoustical properties of buildings such as theatres, concert halls and churches. Initially this research was undertaken with the aid of a mobile laboratory for carrying out tests *in situ* and after 1954 in specially designed laboratories, such as anechoic and echo rooms used for psycho-acoustic research. Much of the work was of a 'diagnostic and treatment' nature mainly for the improvement of badly designed rooms. Later the work led to the use of models scaled down 16x with sound frequencies scaled up 16x. This pioneering work under the leadership of Dr J P A Lochner and later Dr J F Burger and Dr W de V Keet was world acclaimed and was used in the design of concert and other halls, such as the Aula and the Musaion at the University of Pretoria, and the State Opera House in Pretoria.

A major difficulty encountered in the design of auditoria intended mainly for musical performances, was the subjective nature of the criteria used by the exponents of this art form, such as 'warmth', 'clarity', 'brilliance', 'harshness', 'fullness', 'thinness', 'transparency', 'coldness' – to name but a few. The task of the acoustical physicist is to relate these subjective criteria to physically measurable quantities. Through research, the Acoustics Division of the NPRL succeeded in reducing the considerable gap between design criteria for halls intended for speech and those for music. As a result of this research it became possible to design buildings so that the quality of sound would not be distorted and that sound heard by audiences would have the same clarity and pureness of tone as that produced by the speaker, singer or instrument.

Advice was also given on the reduction of noise in industry and the design of buildings to exclude noise. So well did they succeed that these advisory services were increasingly taken over by private consultants.

In the field of acoustic measurements, a sound intensity meter was developed which made use of a new method of measuring the flow of sound energy. The instrument could determine sound output without being influenced by interference from other sound sources, which was not previously possible.

Work on teaching aids for the deaf under Dr F Anderson included the development of prototypes of two devices for displaying voice pitch and rhythmic patterns in visible form. This provided deaf children with information which enabled them to speak more normally. These devices, which took the form of television games which could be used at home, were successfully tested at a school for the deaf and steps were taken for their commercial production.

Other work included acoustic non-destructive testing of materials, the study of long-distance propagation of sound near the ground, underwater acoustics and specialized electro-acoustic systems, such as the speech reinforcing systems used in the Houses of Parliament.

During the 1950s the CSIR was asked to investigate possible alternatives to the nets used to protect bathers from shark attack along the Natal coast. Because the use of sound waves in the water was suggested for this purpose, the problem was referred to the Acoustics Division. In collaboration with the Oceanographic Research Institute, which was engaged in a study of sharks and shark behaviour, experiments were conducted at St Lucia Bay, but it was soon found that in the high noise levels of the surf zone, man-made noises did not affect the behaviour of sharks.

As it was known that fish, including sharks, automatically swim to the positive pole on entering an electrical field, it was decided to investigate the possibility of using an electromagnetic field as a shark barrier. This project was sponsored initially by the Anti-Shark Research Association Ltd and other bodies, and later by the Natal Anti-Shark Measures Board. Following successful practical trials in the St Lucia Bay Estuary during the mid-1960s, further trials were carried out with an experimental cable laid in the surf zone at Margate in 1972. In 1981 an attempt to put a barrier into full-scale

This interferometer is used in applying the national standard of length to calibration in South Africa.



operation was foiled when the specially designed cable snagged on rocks exposed by rough seas and was damaged beyond repair. It was decided that a further attempt should be made with a cable designed and manufactured according to more stringent specifications, and experimental work to determine the most economical and effective operating procedures continued.

Measuring standards

By 1953, the commitments of the NPRL in the field of precise physical measurement in accordance with the provisions of the CSIR Act, had been met to the extent that basic standards of temperature, mass, length, pressure, electromotive force and radioactivity had been established. These standards were in regular use for the calibration of instruments and sub-standards on behalf of the South African Bureau of Standards, industrial firms and research laboratories.

This had not been achieved without considerable difficulty. For example, the General Physics Division, which was responsible for the development of basic standards of mass, length and pressure – all to an accuracy of better than one part in a million – had to wait for five years for the delivery of equipment ordered in 1946. As an interim measure and to enable the staff to gain experience, a commercial balance fitted with specially treated knife edges and planes and an optical device for magnifying the movement of the beam, was installed. It was found that the swinging of the beam would decay but instead of finally coming to rest, would then start to increase again – and that this cycle would be repeated for as long as anyone cared to watch. It soon became evident that this effect was being caused by vibrations

transmitted through the foundations of the building from some remote source. When the equipment was moved to the new laboratory at Scientia this type of problem was eliminated by special design features incorporated in the building. This included strong steel frames on very solid legs resting on the ground. Originally the legs rested on cork blocks, but these were destroyed by termites and had to be replaced by rubber.

Inside these frames solid concrete blocks were suspended from beams which themselves were mounted on rubber blocks resting on top of the frames. In this way a hanging pendulum capable of resisting the strongest vibrations was produced over a wide frequency range.

An example of what was involved in linking these standards to the international standard is afforded by the following quotation from the CSIR's Annual Report for 1969: 'The practical unit of electromotive force (emf) or voltage is maintained in South Africa by a reference group of standard cells at the NPRL. Recently, a group of four cells was transported in a constant temperature carrying box, kept in an upright position throughout its journey to Paris, where the cells were compared with the standard cells of the Bureau Internationale des Poids et Mesures (BIPM). It was found that the difference between the actual emf of the transported cells and that assigned to them by the BIPM was two microvolts, and when the cells were brought back to Pretoria, it was found that their mean value had changed by two tenths of one microvolt. It was thus demonstrated that the South African national standard of emf was within two microvolts of the true value.

'During 1968, the International Committee of Weights and Measures decided in Paris to change the practical unit of emf by a value which would bring it into line with the absolute value of the volt, derived from the basic mechanical units of length (m), mass (kg) and time (s). In accordance with this decision, the national unit of emf at the NPRL was changed by nine microvolts on 1 July 1969.'

Among the NPRL's most notable achievements in methods of improving various standards was the development of an absolute radiometer which was instrumental in improving the international definition of the unit of light. A commercial version was sold to several countries, among them the USA.

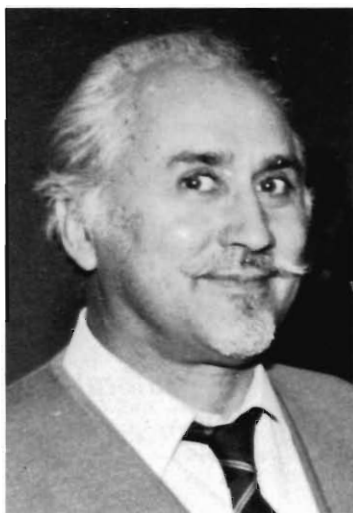
The Measuring Units and National Measuring Standards Act of 1973 defined national measuring standards and traceability of accuracy to those standards. The concept of traceability forms a critical part of quality assurance programmes in industry. Within the framework of this Act a National Calibration Service was set up by the CSIR in 1980, with Dr R Turner of the NPRL as manager, to maintain the accuracy of measuring equipment in use in South Africa. Standards covered are mass, length, time, temperature, electricity, light, ionizing radiation, force and pressure. By 1985 the NCS controlled more than 40 approved laboratories authorized to issue NCS certificates. This service was instituted in response to a demand from industry for calibrations of increasing accuracy because of the growing emphasis on quality assurance programmes, thus reflecting the increasing sophistication of manufacturing industries in South Africa.

*National Calibration
Service*



Dr R Turner
Manager of the National
Calibration Service

A thermal imaging camera, used, e.g., in finding bodies underground after mining accidents, and the resulting image on a monitor.



Dr G J Ritter

Optical sciences

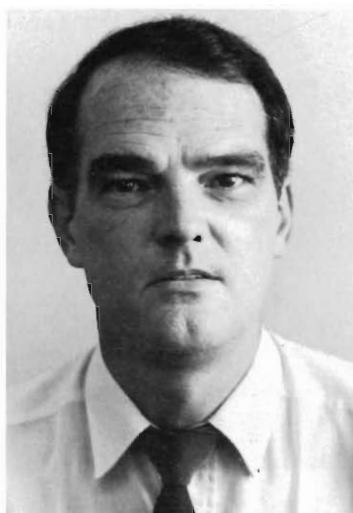
Optics research was a major activity of the laboratory from its inception. Work in this field expanded rapidly with South Africa's need to become self-sufficient after it left the Commonwealth, and the NPRL became recognized as the major centre for optical research in the country. Under the leadership of Dr G J Ritter work in this field was extended to include lasers and holography, optical thin-film technology, electro-optical engineering and image processing. Its knowledge and expertise was also instrumental in establishing a local optical industry.

Highly sophisticated facilities made possible the design of advanced equipment, such as an optical sighting system comprising 50 optical elements in the form of lenses, prisms, mirrors and reticles, and a revolutionary type of lens system particularly suited to night vision equipment, which was simpler in design and cheaper than existing systems. This work was done under Dr M W McDowell.

A thermal imaging camera was developed which could be used, for example, in tracing bodies underground in mining accidents, while in the field of thin-film coatings to achieve specific optical effects, new techniques were developed for a variety of applications, such as for laser mirrors, specialized lenses and infrared spectral region equipment.

International success was achieved with high-power, high-pressure gas lasers, and novel excitation techniques were patented abroad and incorporated into laser products.

The NPRL was involved in digital image processing and application studies of satellite remote sensing data following the launching of the first Landsat satellite in 1972. Pioneering oceanographic work was done by using data from the NIMBUS coastal zone colour scanner.



Dr M W McDowell

Atmospheric physics (cloud physics and air pollution)

The NPRL first became involved in research in the field of atmospheric science in 1949. It carried out experiments in collaboration with the Weather Bureau and the South African Air Force into the artificial stimulation of



The entrance to the CSIR's main campus, Scientia, in an eastern suburb of Pretoria.

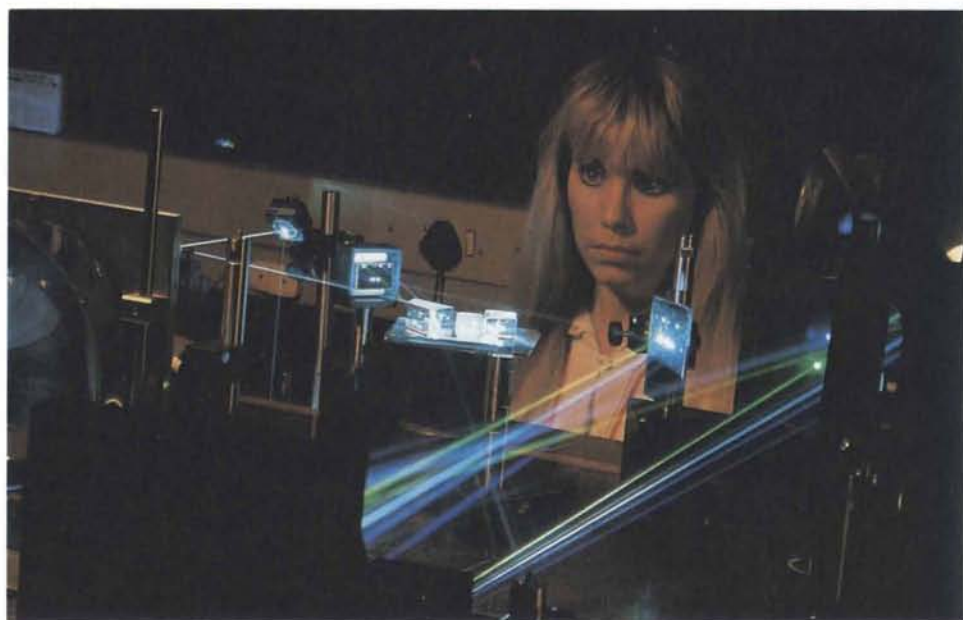


An early evening view of the CSIR Conference Centre in Pretoria.

A seismic explosion created by geologists of the National Physical Research Laboratory during a geochronological exploration of the subterranean layers in the Namib Desert.



Research into the properties and applications of lasers was done by the National Physical Research Laboratory.



precipitation from cumulus clouds by seeding them with dry ice and silver iodide from a Dakota aircraft. These experiments, combined with the results of similar experiments carried out in other countries, confirmed the practical possibilities of weather and even climate modification. As the Americans and Australians were planning comprehensive research programmes to investigate these possibilities, a more limited programme in cloud physics was started in this country by the NPRL in 1956. Recognizing that progress depended on a better understanding of the physical processes involved in the formation of clouds and precipitation, attention was focused initially on atmospheric freezing nuclei and the freezing behaviour of supercooled water.

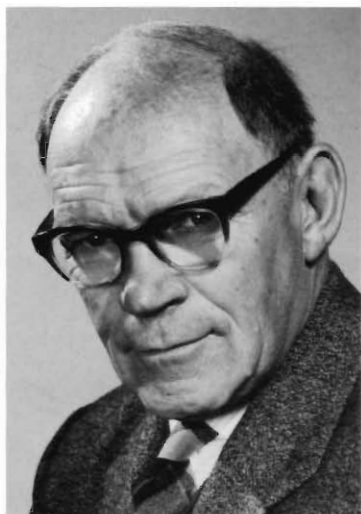
In 1959 the programme was extended to include a study of hail which is of particular interest to South Africa. In co-operation with the Weather Bureau, a network of 'hail-watchers' was established in an effort to gather information on the frequency and occurrence of hailstorms, their altitudes and extent, and the distribution of hailstones of various sizes. As the hailstones themselves provide information on the conditions within the clouds in which they form, hail was collected by 'watchers' for examination in the laboratory as part of a programme to supplement and extend existing knowledge of hailstorms.

This work was supplemented by collaborative research with the National Electrical Engineering Research Institute on lightning flashes and their relation to precipitation. It was further extended by research undertaken in the National Institute for Telecommunications Research into the measurement of precipitation by radar when in 1971 a high-resolution weather radar was brought into operation.

In a related programme, daily determinations of the artificial radioactivity present in dust and rain water, as a result of atom and hydrogen bomb tests, were made at Pretoria. In 1957 these measurements were extended to Windhoek, Cape Town, Port Elizabeth, Beaufort West, Bloemfontein and Durban where the local Weather Bureau stations helped to collect and despatch samples of fallout to Pretoria. The results were reported to the Scientific Committee on the Effects of Atomic Radiation of the United Nations.

In 1954 the Federated Chamber of Industries asked the Government to undertake, through the scientific bodies under its control, such as the CSIR, a scientific investigation of the problem of smoke pollution in cities. At the same time it offered to co-operate in fighting air pollution. On the recommendation of representatives of municipalities, industries and government departments who met in Pretoria the following year, research on air pollution was started with measurements of smoke concentrations in the atmosphere, which were taken in Pretoria, to determine the severity of the problem. In 1958, this work was extended by a measurement programme undertaken by the health departments of Johannesburg, East London and Durban. Two years later, acting on the recommendations of a conference in Johannesburg, the CSIR undertook to establish an Air Pollution Research Group funded by industry, local authorities and the Department of Health. The programme and policy were directed by the CSIR and guided by a

Smoke and air pollution



Dr E C Halliday
Head, Air Pollution Research
Group, 1960-1970

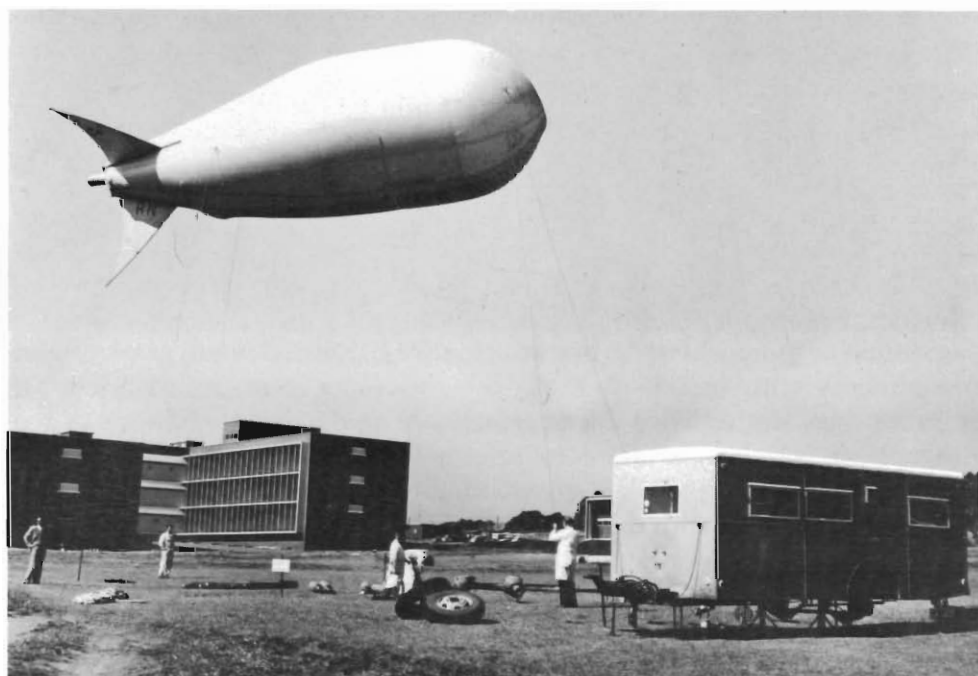
technical steering committee of six technically qualified people, three of whom were appointed by the CSIR and three by a standing committee of contributors. The group started work under Dr E C Halliday of the NPRL with a staff of five.

In the meantime a committee under the chairmanship of Halliday was appointed to draft anti-pollution legislation. It represented the Departments of Health and Commerce and Industry, the Durban municipality and the CSIR. This committee worked for three years to draft the Air Pollution Control Bill which was finally enacted in 1965.

Research by the NPRL and Chemical Engineering Research Group of the National Chemical Research Laboratory, co-operating within the framework of the Air Pollution Research Group, focused on techniques for the measurement of fine dust particles in the gas stream of industrial chimney stacks, vehicle exhaust control and the application of gas chromatographic techniques for the detection of malodorous constituents in the atmosphere in the lee of factories. In addition, the national air sampling network was expanded and in 1970 it was reported that seven major cities and towns were monitoring smoke and sulphur dioxide in the atmosphere. These pollutants, derived from coal combustion, were the greatest problem, especially in the black townships.

In the ensuing years the Air Pollution Research Group continued to make a valuable contribution in the monitoring of various pollutants, in developing analytical methods for monitoring pollution more effectively, and through studies of the underlying physical and chemical processes governing the behaviour of pollutants in the atmosphere. A survey of motor-vehicle pollution in Pretoria, Johannesburg and Durban indicated that the daily ground-level concentrations of the gaseous pollutants, carbon monoxide

Hoisting a balloon used for
measuring changing air
temperatures in smog research.



and ozone, did not exceed the internationally accepted standards; however, relatively high concentrations of nitrogen oxides gave some cause for concern.

The group was frequently called in to advise on the most suitable siting of industrial areas in relation to the planning of urban development. From the studies undertaken in this context, a working model of dispersion was developed for the prediction of pollutant concentration levels arising from a large number of sources in urban areas. This made it possible for town and regional planners to incorporate air pollution on a quantitative basis in their strategy.

In July 1976, Dr Halliday, who had inspired air pollution research and the national approach to air pollution control, retired. He had joined the NPRL on its establishment in 1946 and made many distinguished contributions to the development of fundamental standards of physical measurement, applied radioactivity and biophysics before becoming fully committed to air pollution research. In 1981 the activities of the Air Pollution Research Group were incorporated in the Atmospheric Sciences Division of the National Physical Research Laboratory under Dr A E Carte.



Dr A E Carte

Geophysics

Research in crustal geophysics was undertaken by the NPL from the beginning, with the requirements of the mining industry receiving high priority. It was not until 1969, however, that a separate Geophysics Division, under Dr J S V van Zijl, was formed.

Early work was conducted in close collaboration with the Bernard Price Institute when Dr Ian Gough was seconded in 1947 to do pioneering work on shallow refraction and gravity (with Professor A L Hales of the BPI) and on heat flow (with Dr Carte of the NPL). Valuable work on seismography was done and the first portable hammer seismograph was developed and used with great success in foundation engineering applications.

Gough, with pendulum equipment borrowed from Cambridge University, established 40 pendulum bases throughout South Africa between 1947 and 1950, and in collaboration with Hales completed the first isostatic anomaly map in 1958. This supplemented a field programme by the Geological Survey of gravimeter measurements to produce a Bouguer anomaly map.

In 1962 an urgent and immediate need for ground water geophysics was identified in South West Africa. Dr van Zijl (then in the Acoustics Division) applied seismic refraction methods in the dune areas of the Namib Desert to the south of the Kuiseb River. He used the resistivity method of vertical electrical soundings elsewhere, such as in the Omaruru delta and later Hereroland. Since that time the NPRL has specialized in electrical methods rather than shallow seismic refraction. In the Republic large surveys for ground water were carried out in the Cape Flats, the Breede River valley, the Lamberts Bay area, the Doringberg Fault zone at Richards Bay, in the Western Kalahari and on the Zululand coastal plain. Extensive data led to valuable discoveries and contributions to agricultural and industrial developments.

Ground water exploration

Valuable fundamental investigations into geological structures were carried out by means of electrical resistivity methods. For this purpose the postal and other authorities allowed the use of disused telephone and long distance power lines. Ultra-deep soundings were made for geophysical studies of geological provinces, structural investigations of the Bushveld Igneous Complex and the study of the deep structure of the Archaean greenstone belts.

Ultra-deep soundings

In 1967 Dr van Zijl and his colleagues, using 270 km long telephone lines between Springbok and Kakamas, carried out the first ultra-deep sounding with its centre near Pofadder. A similar sounding, for which the 1 200 km powerline running from near Johannesburg to the Cahora Bassa Dam in Mozambique was used, is the deepest of its kind in the world.

During the 1970s geomagnetic variation studies were carried out under the leadership of Dr Johan de Beer who became head of the Geophysics Division in 1980. The inexpensive magnetic variometer developed by Dr Gough and a colleague was used to determine crustal conductivity changes associated with the transition between the Kaapvaal Craton and the north-eastern boundary of the Namaqua-Natal Belt. These types of measurements were expanded considerably to obtain further valuable geophysical data.

Sinkholes

The dewatering of subterranean dolomitic compartments associated with mining activities on the West Rand was responsible for the development of sinkholes which caused loss of life and property. To study the problem, the Minister of Mines set up a committee in 1962 on which several state and parastatal organizations were represented. Dr A Strasheim, the director of the NPRL, was asked to serve on this committee and the NPRL participated in projects to determine the presence of sinkholes. Many boreholes indicated the alarming presence of subterranean cavities but it was important to measure their size and state of collapse. The NPRL developed and tested several techniques but a photographic probe proved to be the simplest and most effective. Not only could a permanent record be obtained of an underground cavity intercepted by a borehole, but accurate measurements of its size could also be made. This system played an important part in helping geophysicists and engineers to plan future activities.

Geochronology

Radiometric age determinations were first made in the mass spectrometry section of the Optics Division with a gas source mass spectrometer constructed in 1952, one of only four in the world at the time.

Based on the theory of radioactive decay of various isotopes of elements, the accurate determination of mass ratios required high precision instruments which the central workshop was capable of producing. The early mass spectrometers were all self-built and it was only in the early 1970s that commercial equipment became available. Mr J W L de Villiers played an important role in designing and developing instruments used in the NPRL.

The Geochronology Division was established as a separate division in the mid-1950s under Dr A J Burger to collaborate with the Geological Survey, mining houses and universities. Little was known about the relative ages of

the vast geological systems in southern Africa and in view of their potential economic exploitation it was necessary to develop an age determination facility. Making use of sophisticated equipment and methods, the division made valuable contributions to the identification and correlation of geological strata.

The pioneering work of the Geochronology Division carried out in close collaboration with the Geological Survey and chemists from the National Chemical Research Laboratory, resulted in the production of one of the first geological maps in Africa to contain the stratification legend of geological systems based on radiometric age data. This was made possible largely by the high precision thermal ion-emission mass spectrometer perfected at the NPRL.

Much of the success was due to the development of the uranium-lead method applied to extrusive and volcanic (lava) rocks. Geological material investigated included zircon, monozite and galena. Rocks were dated from systems as recent as 550 million years, namely Cape granite (Nama, Damara) to some of the oldest systems on earth (3200 to 3300 million years) found in western Swaziland and the eastern Transvaal area, namely the Figtree series, and the Onverwags Cape Valley granites. There was close collaboration with the Bernard Price Institute at the University of the Witwatersrand.

Natural isotopes

For the age determination of natural substances of more recent origin, a Natural Isotopes Division was established in 1967. Under the leadership of Dr J C Vogel it won international recognition.

Techniques used were the determination of the concentration and concentration ratios of carbon-14, carbon-13, deuterium, tritium, oxygen-18 and other naturally occurring isotopes. As these methods require high precision measurements of very low level radioactivity, background radioactivity caused by solar or other radiation limits their applicability. For this reason work was started on the building of a unique laboratory situated near the eastern wing of the NPRL, and was one of only two of its kind in the world. A special type of concrete was used to build the new laboratory 15 metres below the surface. The background radiation level was thus considerably reduced; for example, the neutron count in the laboratory is 300 times less than the count on the surface.

Subterranean water was one of the most important substances for which age determinations were required in southern Africa. By determining the age of water from boreholes in many regions the flow patterns and replenishment rates were established. It was possible, for example, to show that some ground water in the Kalahari Desert had an age of over 30 000 years and flow rates of two to four metres a year. In contrast, ground water in the vicinity of Satara, Kruger National Park, was found to be of recent origin, indicating the existence of small underground reservoirs entirely dependent on frequent local recharge. This work was invaluable to hydrologists and authorities concerned with the characterization of ground water and the planning of boreholes and water provision.



Dr J C Vogel

Dating methods for archaeologists and climatologists

Applications of natural isotope dating methods in the study of archaeology and climatology dating back 50 000 years were of particular interest. Close collaboration with archaeologists established fascinating and valuable data concerning the development of humanoids and other forms of life on the subcontinent. Some of the findings which indicated that homo sapiens was present in southern and central Africa long before appearing in Europe and the Middle East attracted worldwide attention.

The dating deposits of calcrete, snailshells and fossils aided geological studies of recent systems by verifying sedimentary shift of soils and erosion patterns going back many thousands of years. The dating of ocean waters, precipitation samples and other atmospheric material contributed to studies of atmospheric and marine pollution.

MATERIALS SCIENCE

As much of the early development of the manufacturing industry in South Africa was based on indigenous raw materials, the CSIR national research laboratories and its associated industrial research institutes were concerned with the processing of natural products – animal, vegetable and mineral – and to an increasing extent with the fabrication of products from these processed materials, such as leather, wool, forest products, sugar and bitumen.

As a back-up to these institutes and in providing services directly to the agricultural, mining and manufacturing industries, the activities of the NPL were focused more strongly on the development, refinement and application of sophisticated techniques for the determination of the properties and behaviour of materials. In the early days spectrochemistry and X-ray diffraction took the lead, but when the NPRL moved to new buildings at Scientia, the scope of the work on materials characterization was broadened to include mass spectrometry, electron microscopy and later high pressure physics.

As the application of these techniques was of particular interest to chemical research, a Chemical Physics Group was set up in the early 1960s by the NPRL and NCRL, mainly with a view to sharing expensive equipment.

The following are some examples selected to illustrate the nature of the contributions of the NPRL in the field of materials characterization:

- The spectrographic analysis of leaves, plants, soils and water for the determination of trace element deficiencies and the planning of fertilizer programmes. The project under Dr A Strasheim was supported by the Department of Agriculture.
- The development of spectrographic methods in the late 1940s and early 1950s to determine impurities in uranium oxide, a substance of which South Africa had become one of the main world suppliers. These techniques continued to be used by the uranium industry for the next 30 years.
- The use of direct reading methods for the spectroscopic analysis of metal alloys such as copper base, zinc base, lead base (printers' metal) and high and low alloy steels.

Chemical Physics Group

- The use of spectrographic methods for the determination of the presence and concentration of metal particles in the lubricating oil of engines. Originally developed for the diesel locomotives of the South African Railways in 1957, the methods were improved and modernized by Dr L R P Butler and Mrs D B de Villiers and applied to aircraft engines and systems in the South African Airways and South African Air Force and later to commercial fleet transport vehicles.
- In the application of X-ray diffraction crystallographic techniques, Dr J N van Niekerk was one of the first scientists in the world to characterize metal to metal bonds in transition metal acetates, which led to a new understanding of paramagnetism.
- The compilation of the complex X-ray diffraction spectra of various materials into accessible systems, by Dr van Niekerk, Dr F Herbstein and Dr G Gafner, simplified X-ray diffraction analysis.
- In pioneering work on the high-pressure high-temperature behaviour of materials and mixtures of materials, Dr C W F T Pistorius with Dr P W Richter and later Dr J B Clark evolved the 'master phase diagram' for characterizing materials. Many phase transitions were characterized, mainly by means of X-ray diffraction and differential thermal analysis (DTA) methods.
- With the support of the mining industry, techniques were evolved for the analysis of precious metals including high purity gold (99999+).
- Many different techniques such as optical emission spectroscopy, atomic absorption, spark and ion source mass spectrometry and X-ray fluorescence spectrometry were used by the NPRL in the characterization of moon rock samples – one of the few laboratories outside the USA to participate in this programme.

During the 1960s the requirements of space research programmes, nuclear engineering and new electrotechnology created a demand for new materials capable of performing satisfactorily in previously unknown conditions of heat, cold and pressure. This gave rise to a new field of research which came to be known as materials science.

In 1970 a Materials Science Group was formed within the NPRL. The group grew rapidly in response to the demands of many industrial sectors, which reflected the increasing sophistication of South Africa's manufacturing industries. In 1972 the group was organized into two general activities – the existing and well-established characterization activity and the new materials development activities such as those of high pressure physics, ceramics and glass, and metal physics. At this stage such materials as semiconductors, optical glasses, solid state laser media, optical thin films and special iron and steel were developed.

In 1979 the Co-operative Scientific Programmes started a materials programme aimed at promoting the better use of expertise available at universities and other organizations in national programmes. These programmes proved to be valuable especially in areas where the CSIR had little expertise,

*Materials Science
Group*

*National Institute for
Materials Research*



Dr J B Clark
Appointed Chief Director, NIMR,
in 1983

such as the use of sugar bagasse for producing alcohol and of fly ash for industrial purposes. Another field was the use and disposal of solid waste.

As the need for interdisciplinary studies became more imperative, the entire Materials Science Group was taken out of the NPRL in 1983 and combined with sections from the National Mechanical Engineering Research Institute (NMERI) and the National Chemical Research Laboratory to form a new institute, the National Institute for Materials Research (NIMR) with Dr J B Clark as director. Clark had been head of the High Pressure Physics Division of the NPRL from 1969, and from 1979 was also manager of the National Programme for Materials Science under the CSIR's Co-operative Scientific Programmes.

The sections from the NMERI which were transferred and incorporated into the Metals Division of the NIMR later in 1983 were those concerned with metal mechanics and strength mechanics. They had existed in the NMERI since 1960 and together constituted a strong national facility specializing in metallic materials.

An activity in X-ray photoelectron spectroscopy, built up in the NCRL, was transferred to the NIMR the same year. The equipment for this important new technique was originally intended to stimulate physical chemistry but instead was used mainly in studies of catalyst surface science.

As a multidisciplinary activity, materials science and engineering required inputs from physicists, chemists, metallurgists and mechanical, chemical and electrical engineers. These disciplines were blended in the new institute, as required, in divisions for materials characterization, metals, electronic materials, ceramics, glass and phase studies and electrometallurgy. Under this new arrangement many of the projects initiated by the Materials Science Group of the NPRL were brought to fruition. For example, outstanding research on high energy density batteries started in the NPRL and transferred to the electrometallurgy division of the NIMR, reached a critical phase in 1983. Many of the research ideas had been taken successfully through the early development stage and were expanded in the next advanced development/prototype phase. These batteries, operating at 250 °C and similar in design to the sodium-sulphur battery, offered exciting alternatives to existing storage batteries for electric vehicle and load-levelling applications. A new company was consequently established for their development under the joint sponsorship of CSIR/Saidcor and an industrial partner. Dr J Coetzer and most of his co-workers left the NIMR to form the backbone of the new company at the beginning of 1984. The NIMR continued to be involved in specific contract research for the company while the remaining staff members and facilities concerned with solid state electrochemistry were consolidated within the Ceramics, Glass and Phase Studies Division.

Electronic materials

An achievement of the NIMR's Electronic Materials Division under the direction of Dr H Booyens was the local development of the highly advanced third generation single crystal CMI material for infrared detection purposes. Like most of the work at the institute, this was performed under industrial contract.

*Vacuum tube
technology*

In 1982 vacuum tube technology was identified by the CSIR as critical for South Africa and indeed for the rest of the world. The reason was that while it had been in operation for some decades, the technology was in danger of worldwide collapse owing to the preoccupation of young electronic engineers with the fascinating new field of microelectronics. As a result, certain essential high power electron tube devices were becoming difficult if not impossible to obtain. Deeming this a strategic threat to South Africa, the Electronic Materials Division embarked on a programme for developing a local technology in this area. Within four years several ultrahigh performance high power microwave devices had been taken to prototype stage and the technology was approaching production status.

Achievements of the Metals Division in scientific and engineering application included studies of metal plasticity, surface deformation processes affecting wear behaviour, surface degradation of jewellery alloys, plasma nitriding and nitrocarburizing surface treatments, and ferrous alloy development. Under Dr N R Comins, contract studies for industry grew rapidly and included such fields as alloy development for the mining industry and for ore grinding, the processing of new jewellery alloys, the development of investment casting technology for high-temperature and other industrial applications, ion-plating of precious metals and numerous shorter-term materials selection and failure investigations.

The Ceramics Division, under Dr S Hart, devoted itself to the study of the emerging high technology ceramics field and specific areas in glass technology and optical single crystal growth. The ceramics work centred on structural or engineering ceramics and on special effect ceramics such as piezoelectric transducer materials. Wear-resistant ceramics such as alumina and zirconia were developed, particularly with a view to applications in the mining and manufacturing industries. Improved abrasion and corrosion resistance and toughness make these materials attractive in the aggressive mining environment. Piezoelectric ceramics such as PZT (lead zirconate lead titanate) were developed and their use in ultrasonic transducers led to a local transducer design, fabrication and testing facility at the NIMR.

Ceramics and glass

Back-up provided to the South African glass industry in the context of import substitution included research work in optical filters and machinable glass ceramics. In addition, new initiatives in the growth of optical single crystals used in laser and acousto-optic applications were started in recognition of the rapidly advancing field of optical signal transmission and processing.

Note: Corrosion research in the CSIR which began in the late 1940s and early 1950s in the National Chemical Research Laboratory (NCRL), included bacterial corrosion studies and subsequently led to the formation of a corrosion unit. The Marine Corrosion Fellowship, jointly sponsored by the National Building Research Institute (NBRI) and the Railways, was active between 1954 and 1960. In 1962 the CSIR formed the Corrosion Research Group, administered by the NCRL, thereby consolidating the corrosion research of the NCRL and the NBRI. Part of the group maintained a presence in the south western Cape area. Later the Corrosion Group became a division of the NCRL and building-related corrosion work was returned to the NBRI. (See also under Chemistry, p. 192.)

The NPRL developed a novel scheme for transporting radioisotopes in lightweight containers in aircraft wingtips.



Building on earlier experience in high pressure effects, the Ceramics Division won international recognition in the determination of thermal properties of materials under extreme conditions of pressure and temperature. Results of such studies on special materials aided South Africa's local synthetic diamond producing industry.

NUCLEAR SCIENCE

Before the Second World War research in the field of nuclear physics was limited largely to the leading universities in Europe and America. However, the successful development of the atomic bomb during the war and, perhaps more importantly, the achievement of controlled nuclear chain reaction in the nuclear field, opened up new possibilities for applied radioactivity and the peaceful uses of atomic energy.

In the immediate post-war years, when the CSIR was established, 'artificial radioactivity' and the potential use of radioactive isotopes in biological research and medical diagnostics was something of a novelty. The CSIR had a central role in developing this field of applied radioactivity in this country, and the National Physical Research Laboratory, as the responsible agency, moved fast to establish the basic techniques and control mechanisms. A weekly 'film badge' service was introduced by which the amount of radiation to which a person was exposed was determined by measuring the blackening of a piece of film worn by the individual concerned. By 1954, almost 100 badges were sent out each week to X-ray departments and users of radioactive isotopes.

*Novel scheme for
transporting
radioisotopes*

A novel scheme developed by the NPRL for the transport of radioisotopes in lightweight containers in the wingtips of aircraft, instead of in heavy lead-shielded containers in the cabin, resulted in a considerable reduction in importation costs. This, coupled with a better understanding of their application, brought about a considerable increase in the use of artificial radioisotopes, while the introduction of a similar scheme on domestic air routes facilitated local distribution and delivery of isotopes. It was reported in 1953 that iodine-131 was being imported regularly for medical research, and that during the previous year 236 doses had been administered, the



The underground cyclotron hall under construction at Scientia.

iodine uptake of 242 patients measured, and 95 therapeutic doses distributed. Cobalt-60, gold-198 and routine consignments of phosphorus-32 were being imported for medical and other uses. Other isotope imports included large cobalt-60 and iridium-192 sources for industrial radiography and standard gamma ray sources for the calibration of ionisation chambers. In 1954 there were 33 authorized users of radioisotopes in the country of whom 14 had permission to use radioactivity for medical purposes. The value of isotopes imported in that year increased to R13 000 as compared to R5 200 in the previous year. Users were given advice and wherever necessary, experimental work was done for them in the laboratory and they were trained in the handling of radioisotopes.

On 1 April 1957 the Atomic Energy Board (AEB) took over the importation and distribution of radioisotopes in South Africa. Only a fortnightly subdivision of iodine-131 for medical purposes as well as inspection of the bigger sources continued to be carried out by the Biophysics and Applied Radioactivity Division of the National Physical Research Laboratory which, for the time being, acted as the Isotope Division of the AEB. The NPRL continued, however, to be responsible for the standardization of radioactivity and of radiation dose.

In the meantime Dr S J du Toit, who had joined the staff of the NPRL in 1947, was sent overseas to study nuclear physics with a view to initiating a research programme in this field on his return. While there he visited the Nobel Institute for Physics in Stockholm where work was being done in the field of nuclear spectroscopy, a new development in nuclear physics. This institute had a cyclotron capable of accelerating deuterons to 25 MeV. Du Toit recommended that a similar cyclotron be designed and built at the CSIR by the Division of Nuclear Physics. Such a facility would be necessary in the production of radioisotopes for work in nuclear spectroscopy and could be used as a national centre for the advancement of nuclear physics and training of students.

His proposal that the CSIR should design and build a 16-MeV cyclotron was accepted. The cyclotron hall was completed in December 1953, and a start made with erecting the cyclotron itself, the components having been made



Dr S J du Toit

mainly in South Africa to the design of the staff. In May 1955 the first test could be run – just under four years after the start of this project by the five-member cyclotron team. Initially, a 20-microampère beam of deuterons was accelerated to four million electronvolts and, within a month, this had been increased to six million electronvolts, with a 200-microampère beam. The completion of the associated nuclear physics building during the same year made possible the installation of an intermediate image lens and a betaspectrometer, and a start was made on research into the disintegration patterns of a number of radioisotopes.

The official inauguration of the cyclotron on 26 January 1956 by Dr A J R van Rhijn, Minister of Commerce and Industry, was one of the highlights of the year in the development not only of science but also of technology in South Africa. In May 1956 work began on a new phase of development, as the programme envisaged for the cyclotron required that the beam be extracted from the cyclotron and focused in an adjacent room. Work was also begun on the design and construction of equipment to achieve complete separation of isotopes, i.e. atoms of the same element differing in mass. This was completed and installed in 1959. The cyclotron was used until late in 1958 to irradiate targets of copper, gold, silver, sodium chloride, palladium, lead, beryllium, and other elements with both deuterons and alpha particles and also protons for periods of up to 70 hours at a time. The radioactive products were used for fundamental research into nuclear structures. In 1959 the programme was interrupted for modifications to the building and to the cyclotron to obtain better extraction of the beam.

The facilities in nuclear spectroscopy were largely devoted to the training of students. They received bursaries from the Atomic Energy Board and while registered for doctor's degrees at various South African universities, were

Dr A J R van Rhijn, Minister of Commerce and Industry, opening the cyclotron hall with a radioactive key on the occasion of the official inauguration of the cyclotron at Scientia in 1956.



engaged in appropriate research projects and given lectures of an advanced nature by the CSIR staff.

In 1966 a new betaspectrometer (of which there were only a few in the world), designed and built by the CSIR, was installed in one of the cyclotron's beam lines. Because of its high transmission and good resolution properties, this instrument was most suitable for studying conversion electrons following nuclear reactions. With a view to extending the useful life of the cyclotron by upgrading its auxiliary equipment, two new measuring systems were acquired in 1967, namely a coincidence system for experiments on the external cyclotron beam, and a unit for accurate gamma spectroscopy.

In that year the energy of the external beam was made variable and energies of 6 to 24 MeV were available for experiments. By 1968, the cyclotron had been converted to a fully variable energy machine capable of accelerating protons from 5 to 14 MeV, deuterons from 8,5 to 16 MeV and alpha particles from 17 to 32 MeV. Two 4096 channel analysers were also acquired to facilitate and improve data handling for experiments on the cyclotron and for use in nuclear chemistry.

In 1971, a programme was launched to produce carrier-free radioisotopes for medical applications in South African hospitals. These isotopes with radiation characteristics of particular value in diagnostic medicine were either unavailable or very difficult to obtain from overseas. Iodine-123, for example, which has a half-life of 13 hours, was delivered fortnightly to the Groote Schuur Hospital and Karl Bremer Hospital in the Cape for thyroid diagnosis, while 78-hour-gallium-67 was sent weekly to Groote Schuur, Karl Bremer, the Provincial Hospital in Port Elizabeth and the H F Verwoerd Hospital in Pretoria. By mid-September in 1971, 70 batches (totalling 900 millicuries), prepared to the most stringent standards of chemical purity, had been delivered.

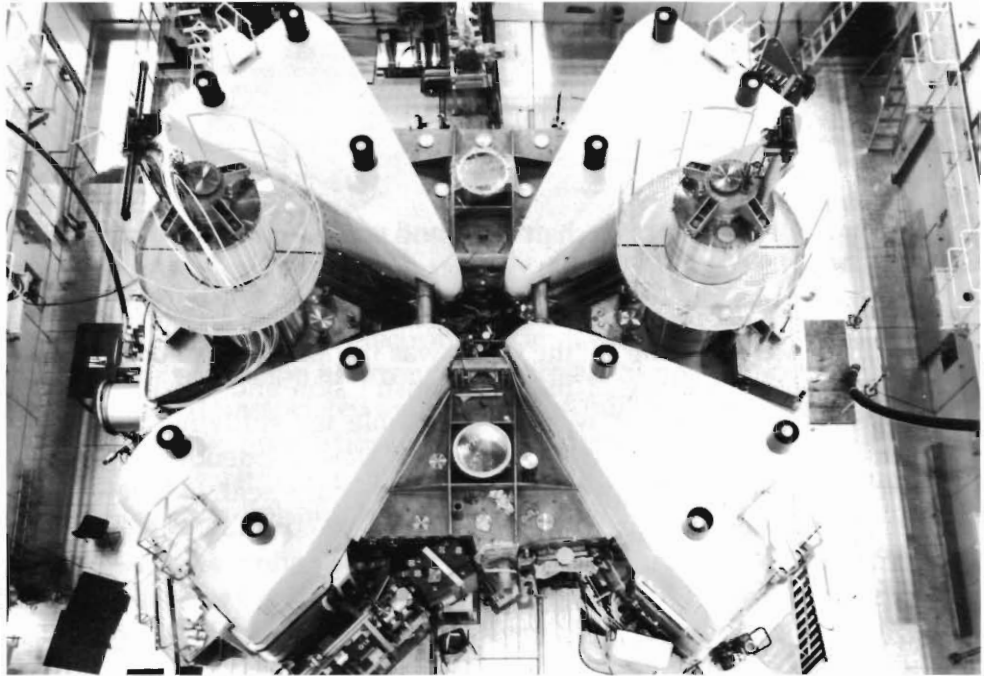
It became increasingly evident during the 1960s that the CSIR cyclotron was no longer adequate; it had been in use for 27 years for research and training as well as for the production of radioisotopes for diagnostic and other purposes.

An investigation instigated by interested scientists and the South African Institute of Physics led to a detailed feasibility study funded by the Cape Provincial Administration. This indicated that most of the important requirements of physicists and radiotherapists could be met by a single large 200-MeV separated-sector cyclotron (in other words, one capable of producing a beam of subatomic particles accelerated to a maximum energy of up to 200 million electronvolts). The proposal for such a national accelerator was approved by the Cabinet in 1975 after thorough investigation and consideration by a number of bodies including the Scientific Advisory Council of the Prime Minister. Because of its many years of experience in this field, the CSIR in 1977 was made responsible for the design, construction and eventual operation of the new accelerator.

It was envisaged that the proposed centre should be developed to serve all South African physicists, chemists, biologists, medical scientists and

National Accelerator Centre

The Separated-sector Cyclotron under construction at the National Accelerator Centre at Faure in the Western Cape.



technologists who were interested in the use and operation of accelerators and the application of accelerator products. The proposed new cyclotron was planned for multidisciplinary use which would include cancer therapy, the production of radioisotopes and basic research. With the new facility it would be possible to produce a larger quantity and wider variety of isotopes and, for the first time, particle therapy, both proton and neutron, would become available in South Africa.

It was announced in the following year that a National Accelerator Centre had been established as a separate national institute of the CSIR, with Dr G Heymann, head of the Nuclear Physics Division, as director. This multidisciplinary research institute was made responsible for the development of the new accelerator facilities near Faure in the Cape, and also for operating the cyclotron in Pretoria and the Van de Graaff accelerator at Faure. The latter was installed in 1963 and was operated until 1983 by the Southern Universities Nuclear Institute when it became the responsibility of the National Accelerator Centre.*



Dr D Reitmann
Director, National Accelerator
Centre, from 1980
(Chief Director from 1983)

The design of the new accelerator incorporated separate facilities for the different disciplines and provided for the beam to be directed magnetically to the appropriate facility as needed, for example medical treatment, isotope production or research. Provision was also made for medical facilities including three cancer therapy vaults, and a medical building with patient handling facilities and wings for radiobiology and medical physics. A 30-bed hospital would be staffed and operated by the Cape Provincial Administration which would be responsible for all patient care and treatment, while the Medical Research Council would co-ordinate all medical research at the centre.

In 1983 the Pretoria cyclotron began planning a programme for the production of fast neutrons for use in radiation therapy in collaboration with the Transvaal Department of Hospital Services. This envisaged arrangements

* The National Accelerator Centre with its headquarters at Faure was formally opened by the State President on 18 October 1986.

for the treatment of certain types of cancer to be carried out at the cyclotron by radiotherapists, radiographers and medical physicists from the H F Verwoerd Hospital, the Hillbrow Hospital and the Johannesburg Hospital.

MATHEMATICAL SCIENCES

In 1954 a separate Division for Mathematics was formed within the framework of the National Physical Research Laboratory. One of its most important functions was to assist other laboratories of the CSIR in the solution of their mathematical and statistical problems.

An early project in which the division became involved was the statistical treatment and testing of data arising from the investigation of rockbursts in mines by the Mechanical Engineering Research Unit, the forerunner to the National Mechanical Engineering Research Institute. Activities of this kind expanded in response to demand until in 1959 the Mathematics Division was engaged in collaborative research projects and the provision of services in the following fields:

- Mathematical statistics and applied statistics (much of which concerned the design of experiments and analysis of data).
- Biometrics (mainly on behalf of CSIR medical research units).
- Computational mathematics – the installation of the STANTEC-ZEBRA computer introduced a new dimension in this field which included the provision of computing services and the training of members of various organizations, within and outside the CSIR, in computer programming.

In 1961 the Mathematical Division and the Electrical Engineering Research Division were reconstituted to become a separate National Research Institute for Mathematical Sciences (NRIMS). The first director was Dr A P Burger, who later became a vice-president of the CSIR and subsequently scientific adviser to the Prime Minister. On Dr Burger's promotion to the CSIR executive in 1973, Professor C Jacobsz, head of the Institute's Numerical Analysis Division and previously professor of mathematics at the Universities of Stellenbosch and Pretoria, became director of the NRIMS. He retired the following year and Professor D H Jacobson of the Department of Applied Mathematics at the University of the Witwatersrand was appointed in his place. When he in turn was appointed a vice-president of the CSIR in 1980 he was succeeded by Dr D H Martin.

Towards the end of 1970 the institute's Department of Electrical Engineering became a separate National Electrical Engineering Research Institute of the CSIR. However, the computing services remained the responsibility of the NRIMS. The demand for these computing services grew to such an extent that in 1978 a separate national institute known as the Centre for Computing Services was formed.

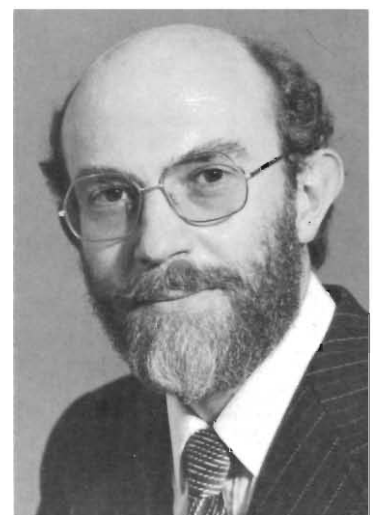
Although developments in numerical analysis and computation had tended to dominate the scene, research in the various branches of mathematics and their applications to research continued to develop in support of scientific and industrial endeavour in South Africa. In fulfilment of these functions,



Dr A P Burger
Director, National Research
Institute for Mathematical
Sciences, 1961-1973



Professor C Jacobsz
Director, National Research
Institute for Mathematical
Sciences, 1973-1974



Professor D H Jacobson
Director, National Research
Institute for Mathematical
Sciences, 1975-1980



Dr D H Martin
Director, National Research
Institute for Mathematical
Sciences, from 1980
(Chief Director from 1983)

*Computerized decision
support systems*

the NRIMS collaborated with other organizations in a variety of research and development projects.

By 1985, the main activities in which the Institute was involved included the following:

- Studies in dynamic meteorology (begun in the early days of the institute by its first director, Dr A P Burger, in collaboration with the South African Weather Bureau) were aimed at, among other things, the development of models of the atmosphere and the computer implementation of improved operational prediction models.
- The computer modelling and simulation of cumulus clouds, including the effects of seeding for rain enhancement.
- The development under contract of computerized decision support systems for various clients, with conceptual and methodological studies to advance the technology of management decision support. Specific applications included a system for production and distribution planning for a large beverage producer, and one for assisting in design calculations for a mining equipment manufacturer.
- The study of deterministic and stochastic differential games as models of situations of partial or total conflict.
- Optimization and methods of operations research, with diverse applications for various clients to such problems as the stability of tunnels in jointed rock, the modelling of assets and liabilities in merchant banking and the analysis of water-release strategies from storage dams.
- The mathematical and computational treatment of partial differential equations, with applications to problems such as the overheating of earth electrodes.
- Studies in computational nuclear physics.
- The development of computerized cartographic systems for special applications.
- The development of practical methods of statistical analysis, and their application to a wide variety of problems as part of an ongoing statistical advisory service.
- The systems-dynamic modelling of energy demand in South Africa for purposes of long-range demand forecasting under the National Energy Research Programme.
- The development, in collaboration with the National Electrical Engineering Research Institute, of a large multimicrocomputer system.
- Advanced studies in algebra, analysis, optimization and the mathematics of pattern recognition.
- The development under contract of large special-purpose software systems, such as a laboratory automation system for the National Institute for Water Research and software for a computerized traffic data logger with the National Institute for Transport and Road Research.



The radio carbon dating facility of the National Physical Research Laboratory. Determining the age and thickness of layers in stalagmites can provide information on past rainfall patterns.

A selection of various types of special-purpose glass developed at the National Institute for Materials Research.



A glowing disc of silicon is taken from a furnace in the IC manufacturing facility of the National Electrical Engineering Research Institute.





The first electronic digital computer, code-named ZEBRA, was installed at the CSIR in 1958 to facilitate automation in research. It recorded data on punched paper tape, which could then be fed into the computer.

- Studies in theoretical nuclear physics to support and interact with experimental groups using the 200-MeV cyclotron being built by the National Accelerator Centre.
- Studies in the field of water resource planning in close collaboration with the Directorate of Water Affairs, such as the operational research problem of selecting good strategies for water release from reservoirs.
- Development of special programming languages, such as a special high-level language called SCRAP (Systems ConstRuction and Applications Programming), especially well suited to systems programming on mini-computers.
- Maintaining expertise and providing assistance in the development of software (involving highly specialized computer programming) required for new types of numerically controlled equipment.

To sustain a team of mathematicians, operations researchers and computer scientists capable of applying high level knowledge and skills to difficult problems, the institute maintained a vigorous theoretical and methodological component in its research programme. This was aimed at improved understanding of various mathematical, physical, technological, computational and managerial questions, and the development of improved methods for the analysis and treatment of problems in these areas. Of great value in this context was an active visitor programme whereby five or six experts in various fields were invited to visit the institute as guest workers for several months each year.

*Theoretical and
methodological back-up*

COMPUTATION AND INFORMATICS

The first electronic digital computer at the CSIR was installed in 1958. Code-named ZEBRA, its immediate purpose was to facilitate automation in research by recording data in binary form on punched paper tape. This tape could be fed into the computer to carry out all the computational procedures in a minimum of time and at a fraction of the cost required for conventional methods of registration and analysis of such data.

*Scientific computing
capabilities initiated
and extended*

The role played by computing services in research at the CSIR gradually increased in importance. In 1962 the Numerical Analysis Division of the National Research Institute for Mathematical Sciences was entrusted with the task of forming a computing group (which eventually evolved into a Computing Centre within the NRIMS) with a mandate to provide for the computing requirements of the whole CSIR. Its responsibilities were, in fact, wider than this as the CSIR looked to it to take the lead in scientific computation in the country and to serve as a national source of information and expertise covering all aspects of the field.

In the same year computing services were stepped up by the acquisition of an IBM 704 and the introduction of the FORTRAN programming language. The 704 soon became inadequate and was replaced in February 1967 by the more powerful IBM System 360/40. The computer was linked by telephone lines to the National Institute for Personnel Research in Johannesburg for the daily transmission of data for computation.

The computer load increased steadily, and when it became evident that the existing installation would be loaded to capacity by the end of 1968, an order was placed for an IBM 360/65 configuration.

When this computer first came into operation the enhancement was such that it was at first in use for only a few hours a day. However, such was the growth in demand, and more particularly for increasing sophistication of computing services, that early in 1970 an overflow shift had to be introduced. To meet this need for increasing sophistication, peripheral equipment was upgraded. From 1975 the demand for computing services at the CSIR increased enormously. The central processing unit of the IBM 360/65 was replaced by an IBM 370/158. Although the throughput of this system was about 30 per cent greater than that of the IBM 360/65, it was only temporarily capable of coping with the increasing demands. The CSIR was thus forced to increase the computing power still further. The IBM 370/158 system was retained to be used only for information processing, administrative applications and creation of data bases. In addition, a Control Data CYBER 174 was installed in 1976 for scientific and engineering applications ('number crunching') and time sharing requirements. This was augmented by a powerful CYBER 750 machine in 1982.

*Systems user and
operations support*

The Computing Centre staff was subdivided into three groups: a systems support group, a user support group and an operations group. The first of these groups was concerned with the maintenance and extension of the operating system of the computer. The user support group maintained direct liaison with the users; its work included consultative and advanced programming assistance (the emphasis being on assistance, users being expected to write their own programs), the maintenance of an information service, the maintenance and extension of a program library and also training in advanced programming techniques. The operations group saw to the running of the computer, scheduled the work and managed the punching service, stores and related services.

A significant development was the establishment of a data communications network to facilitate access to the central facilities for local and remote asynchronous terminal users. The setting up of this network was started in

1979. It had two basic components, namely an on-campus ring with nodes at most institutes, servicing about 350 terminals, and an off-campus network connecting about 130 terminals, based on leased lines and SAPONET circuits with nodes in Cape Town, Stellenbosch, Faure, Hermanus, Port Elizabeth, Durban and Johannesburg. This network was used to connect minicomputers and mainframe computers at various universities and CSIR institutes countrywide. There was also a synchronous SNA-based network servicing a total of about 370 local and remote terminals. With SAPONET-P X.25 services generally available to most cities and towns, and with the introduction of DIGINET, increasing use was made of South African Post Office remote traffic facilities, which were expected to supplement the CSIR's leased line remote network to an ever increasing degree.

A further step was the introduction of a measure of decentralization with the installation in 1984 of a Control Data CYBER 815 in Faure. This machine was intended to provide for the general purpose scientific computing requirements of CSIR users in the western Cape. It was linked to the 174 and 750 in Pretoria by way of high-speed dedicated lines and provided the user with interactive access and job submission to any machine depending on his requirements. Some institutes, such as the National Electrical Engineering Research Institute and the National Institute for Telecommunications Research in Johannesburg and National Research Institute for Oceanology in Stellenbosch, had obtained their own minicomputers for specialized applications. These machines were also linked to the central facilities in Pretoria as remote job entry stations enabling job submission and output retrieval. Recent years have seen a proliferation of personal computers in the CSIR and an increasing need to link these either individually or in the form of local-area network gateways to the central facilities.

In terms of its responsibility for promoting national scientific and technical research, the CSIR agreed to make available from 1983 onwards up to 10 per cent of the 1983 computing capacity for approved university research projects requiring large-scale computing. As indicated above, by 1985 eight universities had minicomputers and mainframe computers with terminal access to the CSIR facilities stimulating this type of research at universities.

The most important aspect of computer use at the CSIR was numeric computation (for scientific and engineering applications) and almost all the research institutes and laboratories made use of the facilities in this way. For example, the Numerical Analysis Division of the National Research Institute for Mathematical Sciences became involved in the computing, training and liaison aspects of the first numerically controlled milling machine acquired by the Technical Services Department of the CSIR in 1968.

In 1969, when the comprehensive integrated civil engineering system (ICES) of the Massachusetts Institute of Technology in Boston was implemented and tested on the computer with a view to adapting the system to South African conditions, NRIMS, through the South African Institution of Civil Engineers, invited consulting engineers to help in testing the system by submitting design tasks encountered in their own practice. This was part of a long-term programme aimed at promoting the use of the computer for engineering design and analysis through the medium of general and

*Numeric computation
services*

*Engineering design
and analysis*



Dr E N van Deventer
Promoted Director, Centre for
Computing Services, in 1979

specialized applications software such as ICES (and later GENESYS), and finite element analysis programs such as NASTRAN and ASKA which were then becoming available.

Data processing requirements originated from sources as varied as research in pneumoconiosis, earth magnetism, the use of scientific literature and the distribution of hailstones. Programming assignments were even more varied and ranged from the development of techniques and computational methods for the assessment of aircraft noise near airports (which received international recognition for incorporation in national standard procedures) to the eclipse of binary stars, tables of heat conduction, the simulation of process control systems, transonic flow theory, control system analysis and the design of cooling towers. The need for pictorial analysis and presentation was also growing and by 1985 graphics applications, as well as image processing and computer-aided design facilities, were being provided.

However, there was also an expanding non-numerical data processing component. Major users of these facilities were the information services of the CSIR (primarily for computer-aided information storage and retrieval, library mechanization, data base applications, and word and text processing) and the administrative services (for such functions as financial control, personnel administration and management). This resulted in the development at the CSIR of expertise in more or less every aspect of computer applications. In the context of both numeric/scientific and non-numeric data processing there was a growing demand for remote access to the central computing systems (particularly for interactive computing).

In 1979, the Computing Centre was separated from the NRIMS as a national institute of the CSIR to be known as the Centre for Computing Services. The head of the centre, Dr E N van Deventer, was promoted to director. In January 1980, Dr van Deventer was appointed a vice-president of the CSIR and was succeeded by Mr V A Shaw, formerly of the National Building Research Institute where he had been concerned with computer applications in civil engineering and the construction industry.

The Centre for Computing Services and the CSIR's Centre for Scientific and Technical Information were amalgamated in 1984 to form the National Institute for Informatics. Mr Shaw was appointed chief director.

The amalgamation was considered of great importance to both the CSIR and the country as a whole as a means of keeping pace with the rapid developments in the field of information technology.

ELECTROTECHNOLOGY

Research in the field of electricity featured prominently in Dr Naudé's plans for the development of the National Physical Laboratory. For this purpose he appointed Dr R Guelke, senior lecturer in the Department of Engineering of the University of Cape Town. Another senior appointment was that of Dr Otto Brune who was known worldwide for his work on formalizing the mathematical basis for the synthesis of electrical networks.

By 1953, the Electronics Group, in addition to work in connection with the establishment and maintenance of electrical standards and undertaking routine calibrations on behalf of other bodies, had the following achievements to its credit:

- The design and manufacture in the laboratory of specialized vacuum tubes not available commercially.
- Development of equipment for analysis of the behaviour of servomechanisms which made it possible to set up a proposed control system (or a scale model of it) and, by means of a limited series of readings, to predict its behaviour under various conditions likely to be encountered in practice.
- The design and construction of analogue computers for special purposes, such as working out the structure of crystals from X-ray diffraction data. On the return of a research officer who studied analogue computers overseas on a UNESCO bursary, the first general purpose repetitive analogue computer in South Africa, called the HEIDEN, was developed. This was primarily employed for solving non-linear differential equations used in feedback control systems and was in use from 1954 to 1968.
- *Ad hoc* projects, mainly in the context of instrumentation for research, such as the design of a soil pressure cell for the National Building Research Institute.
- The development of sensors for measuring radioactivity and temperature in deep-level prospecting boreholes used in the search for gold in the Orange Free State. Because of the limited size of the boreholes, no suitable instrumentation was available and the use of a single wire for both suspension and signal transmission was a world first.
- The use of magnetic amplifiers in the control of industrial processes and of industrial automation in particular. An automatic conveyer control for a mineral producing plant in Natal was certainly a first in the country.

In 1958, a research officer of the Electrical Engineering Division was one of a two-man team visiting Britain and other European countries to report on digital computers available on the market. On the basis of this report an order was placed for a digital computer for the Computation Section of the Mathematics Division. The Electronics Division was responsible for the installation of this computer, codenamed ZEBRA, in collaboration with the manufacturers, Standard Telephones and Cables Ltd. (ZEBRA was the acronym for the Dutch words 'Zeer Eenvoudig Binair Reken-Apparaat'.) Standard Telephones subsequently undertook its operation and maintenance. ZEBRA was brought into operation over a period of about a month and during the first three months of operation availability averaged 98 per cent.

As mentioned earlier, the services of the Electrical Engineering and Mathematics Divisions of the National Physical Research Laboratory were combined in 1961 in a National Research Institute for Mathematical Sciences (see p. 147). Ten years later the Electrical Engineering Department of this institute became a separate National Electrical Engineering Research Insti-

*Electronic digital
computation*

*National Electrical
Engineering Research
Institute*



Mr J D N van Wyk
Director, National Electrical
Engineering Research Institute,
from 1971
(Chief Director from 1983)

tute. Mr J D N van Wyk, who had joined the staff of the National Physical Research Laboratory in 1950 and been head of the Electrical Engineering Division of that laboratory since 1961 and subsequently head of the Electrical Engineering Research Department of the NRIMS, was appointed director. At the time of its establishment, the new institute comprised divisions for signal processing, automation, applied electronics, solid state electronics, electronic instrumentation and power electrical engineering. These divisions were engaged in research in a diversity of fields such as computer technology, process control, applications of digital techniques to data processing, information theory and signal processing, medical electronics, thin-film and semiconductor technology and its applications to electronic circuit systems and microminiaturization, and problems peculiar to southern Africa in heavy current applications.

The period after 1970 saw further development of the National Electrical Engineering Research Institute as a national focal point of expertise in new and rapidly developing fields - such as microelectronics, cybernetics and high-voltage power transmission systems - and their applications in local circumstances in response to international trends.

For example, the institute became involved in the design of miniature radio transmitters for tracking wild animals in wildlife management research. The directional antennae had various designs to satisfy different requirements with regard to sensitivity, portability and transportability. In the light of practical experience, the circuits were modified to meet the requirements of wider temperature ranges and moisture proofing. Activities in the field of biotechnology extended to the medical field, such as the development of small telemetering systems for transmitting physiological data to monitor the condition of patients. Towards the end of 1971 a symposium on biotelemetry was organized by the CSIR in collaboration with the Medical Research Council and other organizations. Eminent research workers from overseas were guest speakers.

Lightning research

Because of the high incidence of lightning over the central areas of southern Africa and the importance of lightning as a parameter which has to be considered in the design of power systems and communications networks, a programme was undertaken to measure the number of lightning discharges to ground per square kilometre per year. For this purpose a suitable lightning counter was developed and calibrated. With the financial support of the Electricity Supply Commission, the South African Broadcasting Corporation and the South African Railways, 400 lightning counters of this type, constructed by a local firm, were ordered. This flash counter was an improvement on existing internationally accepted counters as it was less sensitive to intercloud flashes, which were not of interest to this survey. This counter was subsequently accepted by the international organization Conférence Internationale des Grands Réseaux Electriques (CIGRE) as the standard counter to be used in all calibration of other existing counters. The counters were installed at 400 selected sites; most of them were read daily and the readings processed at the CSIR. A computer program was developed to analyse the data and to produce contour maps showing regional variations over a 10-year period.



A lightning flash strikes the top of the 60-metre high tower erected on the CSIR site to study lightning properties.

For the more detailed study of the lightning flash a 60-metre tower was erected on a hill at the CSIR site. The tower was insulated from the ground, and by means of special instrumentation it was possible to measure directly the magnitude and duration of lightning currents when the tower was struck. Currents of up to 70 000 A were observed. Remote cameras and a closed circuit video recording system made possible the detailed examination of the actual path of lightning strokes in the air. The knowledge gained through these studies proved to be invaluable in the design of protection systems and led to improved procedures for electrical engineering practice. A third aspect of the work involved extensive recording and analysis of lightning surges on 500-kV transmission and distribution lines, the +150-kV Cahora Bassa DC link and on an 11-kV rural distribution line specifically built by Escom in a joint research project.

The head of the institute's lightning team, Dr R B Anderson, was for 14 years chairman and convenor of the international working group on lightning of CIGRE. This working group co-ordinated research and the application of results on a worldwide basis. On Dr Anderson's retirement in 1985, Dr A J Eriksson succeeded him in the institute and also as chairman of the CIGRE working group.

In 1984, the National Electrical Engineering Research Institute secured a contract worth more than R400 000 to act as principal contractor for the design and construction of a sophisticated automatic lightning research station for a Brazilian electricity supply company. The institute also assisted in the final commissioning of this station in Brazil towards the end of 1985.

Battery-driven vehicles

The institute's contribution to lightning research won international recognition and in South Africa it received the National Award of the Associated Scientific and Technical Societies in 1982 and later a Shell Design Award for an improved lightning warning system.

Under the impetus of the energy crisis of the 1970s, the institute became involved in a research and testing programme to determine the performance of battery-driven vehicles under normal conditions of use. The project was undertaken in co-operation with a well-known manufacturer of electrical equipment and a West German consortium. Two vehicles were included in the programme - a van used for deliveries on the CSIR site and a minibus for daily journeys to central Pretoria. By 1985 the two vehicles had done 90 000 km at an average electricity consumption of 0,61 kWh/km, or roughly 3c/km at the ruling electricity tariffs. At that stage the flat-plate batteries which were originally used were replaced with a new type of tubular-plate battery which was expected to have a longer service life. A development programme to improve the efficiency and lower the cost of drive systems was also started, and this resulted in a successful demonstration sedan car equipped with an automatically controlled gear change and simplified speed control for the motor. Furthermore, a unique type of traction motor of disc construction was developed for testing in the same vehicle. It offered high efficiency, simple construction and low inertia.

The institute also became increasingly involved in research on high-voltage industrial installations. Several years of intensive research into the occurrence of severe switching surges in high-voltage motor installations yielded a clear understanding of the various processes involved. This was made possible largely through the installation of a comprehensive range of sophisticated measuring facilities in the institute's mobile surge-recording laboratory. A variety of surge-protection and suppression techniques were tested and evaluated under actual operating conditions. This led to recommendations regarding optimized surge suppression in high-voltage motor circuits and the provision of advice to manufacturers on insulation and improved switchgear design.

In 1979 a facility using a high-voltage transformer hired from the South African Bureau of Standards was designed and built on behalf of an industrial concern for a programme of accelerated life studies on 200-metre lengths of high-voltage cables. Within six weeks, two different types of faults, closely resembling those experienced in practice, had developed. The faults were diagnosed and remedied, thus saving a potential production loss of R1 million a day at the production installation.

High-voltage transmission

In 1982 equipment was installed at the National Electrical Engineering Research Institute for a comprehensive outdoor laboratory for extra-high-voltage engineering research. These facilities, as well as the proposed research and testing programmes, had been planned for many years by a co-ordinating committee of the CSIR, Escom, the South African Bureau of Standards, the universities and industry. The main aim in establishing the facility was to develop background knowledge of the engineering parameters appropriate to the efficient design of high-voltage transmission systems



Equipment for the outdoor laboratory for extra-high-voltage engineering research at the National Electrical Engineering Research Institute (installed in 1982).

for use at high altitudes, taking into account the great exposure to lightning in many parts of southern Africa.

By 1985 the institute was already making important contributions to international studies of atmospheric correction procedures and the development of advanced high-voltage impulse measurement techniques.

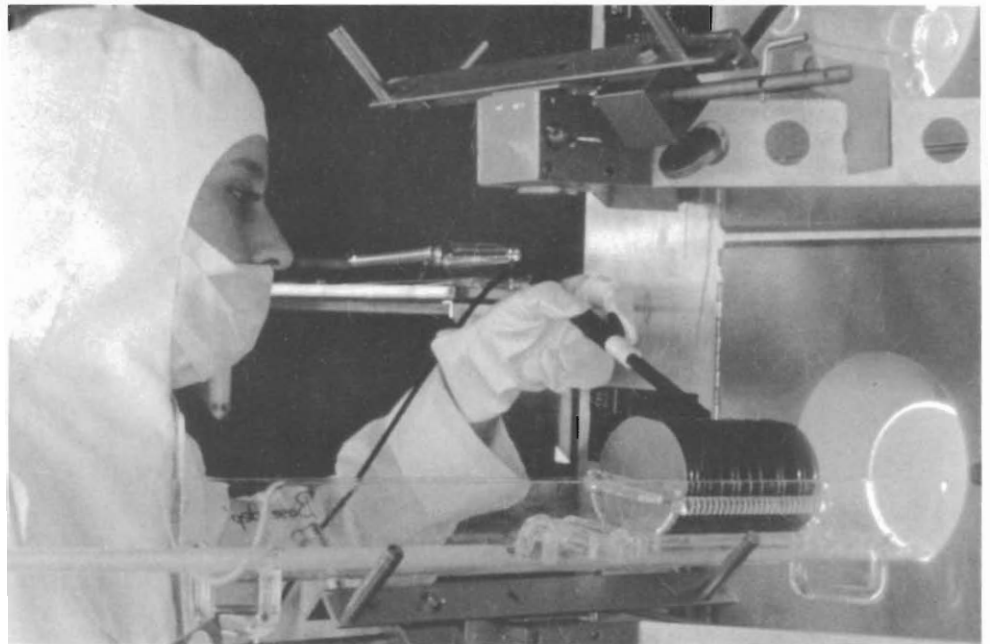
In the rapidly developing field of microelectronics, with its great potential for technological innovation, the role of the institute was primarily to maintain a level of expertise which would enable it to serve as a window on developments elsewhere. Considerable know-how in integrated circuit technology was gained following the acquisition in 1970 of a high-temperature diffusion oven, and by 1974 experimental bipolar integrated circuits were being designed and manufactured in the Institute. The production of masks for microcircuits and printed circuit layout could be speeded up when a computer-aided design system was commissioned. The system was used to produce layout data for several monolithic integrated circuit masks as well as layouts for printed circuits for further processing with the numerically controlled pattern generator of the CSIR's Technical Services Department. When a step-and-repeat camera was acquired by the institute, masks of a higher quality could be made.

In view of the availability of these facilities and the expertise developed by the CSIR for making the integrated circuits required for the experimental work of its own laboratories, it was decided to create a facility for the regular production of custom-designed circuits required in limited numbers by other agencies and local industries. To this end the CSIR entered into an agreement with a semiconductor manufacturer for licensing a bipolar process and rendering technical aid. When this facility was formally opened in August 1976, it was emphasized that it was available to industry for the making of non-standard items.

Microelectronics

Integrated circuits

In a dust-free 'clean' laboratory the CSIR pioneered the way for the establishment by industry of South Africa's first full-scale integrated circuit facility and design centre.



Although a relatively small undertaking, it was operated under production conditions with full quality control and had the capability of producing more than a million circuits annually in chip form (unencapsulated). It was stressed that it was neither the function nor the intention of the CSIR to extend this facility into a full-scale factory. Its aim was rather to encourage the South African electronics industry to develop its own proprietary electronic systems for local production. By 1985 it had produced some 2,5 million special transistors and 60 000 special ICs for local industrial use. This pioneering work also paved the way for the establishment by private enterprise of the first full-scale integrated circuit facility and design centre in South Africa.

Computer technology

In the field of computer technology the institute developed several mini-computers which led to the establishment of a series of local computers produced by industry. Many new techniques were pioneered in signal processing and original contributions were made to coding techniques and error correction in digital transmissions. The institute also became involved in a programme of speech processing to reduce bandwidth requirements for transmission and storage. In a joint project between this institute and the National Research Institute for Mathematical Sciences a multimicroprocessor computer was developed which was expected to compare with state-of-the-art supercomputers in particular applications. The computer technology was also used for the design and construction of a fast Fourier transform computer with special high-level dynamic performance.

Instrument calibration

Virtually from its inception as a division of the National Physical Research Laboratory, a service was provided to CSIR institutes and other organizations in the calibration of electronic instruments. On the establishment of the National Calibration Service under the auspices of the CSIR in 1980, the calibration laboratory of the National Electrical Engineering Research Institute was one of the first in the country to be approved by the Calibration

Service and was graded in the highest category of electrical measurement accuracy capability.

The training of electronic technicians was originally introduced to meet the needs of the CSIR institutes. This training scheme, involving alternate sessions of full-time theoretical classes at the Pretoria Technikon and intensive practical training at the institute's training centre, was made available to other organizations.

The Industrial Electronics Division of National Electrical Engineering Research Institute was originally established to develop and manufacture specialized measuring and control systems. Its activities expanded over the years and a wide electronic product development service was offered to government departments and industry. Developments of this division included a powerful portable data logger which was customized for a variety of applications; for example, at a meteorological station, an electroplating line controller for a manufacturer of printed circuit boards, data acquisition and control equipment for an electric vehicle and a control element used in numerous complex water quality measuring systems. Other activities, in collaboration with CSIR research institutes and other research organizations, included participation with industry in projects involving data acquisition and control in the field of sugar refining, gold ore reduction and sawmilling.

The institute played a key role in promoting co-operation nationally and internationally in the field of automation and computation when in September 1957 the International Federation of Automatic Control (IFAC) was formed in Europe. The CSIR was among a group of organizations invited to represent South Africa.

As no single body covered the full spectrum of the potential activities of IFAC, Dr Otto Brune called a meeting of those organizations and societies with an interest in automation. It was decided to form a separate non-statutory South African Council for Automation and Computation (SACAC) with Dr Brune as its first president. In 1961 this council became a member of IFAC and South Africa has continued to be one of its 42 affiliated countries.

Mr J D N van Wyk subsequently became a president of the S A Council for Automation and Computation and in 1968 became involved more directly in the affairs of IFAC. He served as vice-chairman and chairman of the Technical Committee on Computers, was a member of the Policy Committee, and a vice-chairman of the Technical Board responsible for four of the technical committees, namely computers, applications, manufacturing technology, and terminology and standards.

The council continued to grow and by 1985 had a membership of 37 full members and 30 associate members. As is the case with IFAC, its membership is not made up of individuals but of organizations or companies.

The many-faceted activities which have been described reflect the aim of the institute to co-operate with industry in stimulating technological developments in selected fields of particular relevance to economic growth in South Africa.

Industrial application

SA Council for Automation and Computation



Dr W L Grant
Director, National Mechanical
Engineering Research Institute,
1957-1959

*National Mechanical
Engineering
Research Institute*



Dr H G Denkhaus
Director, National Mechanical
Engineering Research Institute,
1960-1980

MECHANICAL ENGINEERING

A survey of the mechanical engineering problems with which the future development of industry was confronted, was undertaken in 1950 by Dr A J A Roux, head of the Functional Efficiency Division of the National Building Research Institute, in collaboration with the Liaison Division. Arising out of this survey, the Council decided in April 1951 to establish a Mechanical Engineering Research Unit with Dr Roux as head. (In 1952 Dr Roux was in addition, appointed director of the National Physical Laboratory – see p. 125).

This Unit came into operation at the beginning of 1952. Two wind tunnels and associated buildings on the new site were transferred to it from the National Building Research Institute. One of them was a 10-ft diameter low-velocity tunnel designed for research on ventilators and ventilation studies on model buildings, and the other was a medium-speed tunnel with a 2-ft octagonal shaped working section designed primarily for the calibration of airflow instruments. Equipment acquired by the National Physical Laboratory for research on metal physics, was also taken over by the unit. Thus equipped, a start was made on a programme of sponsored research projects, related mainly to the needs of the construction, mining, transport and energy industries. For this purpose Roux gathered around him a team of gifted young engineers who were to make outstanding contributions in various fields.

The Mechanical Engineering Research Unit developed rapidly and in October 1955 became a separate national research institute of the CSIR, the National Mechanical Engineering Research Institute (NMERI), with Roux as its full-time director. The demand for services from industry and other sources increased and by 1956–57 contract income amounted to £37 000. One contract of unusual interest was the design and construction of a climatic chamber and human calorimeter for the Applied Physiology Unit of the Chamber of Mines. In 1958, when Roux was appointed a vice-president of the CSIR, there were active programmes of research and development in the fields of metallurgy, strength of materials, mechanics, heat transfer, air-conditioning and refrigeration, hydromechanics and aerodynamics. Dr W L Grant, who succeeded Dr Roux, left to join the staff of the Atomic Energy Board and Dr H G Denkhaus was appointed director in 1960.

The activities of the institute were organized into four main branches: hydromechanics, aeromechanics, heat mechanics, and materials and solid mechanics (including geomechanics and manufacturing technology).

Hydromechanics

With the establishment of the Hydraulics Research Unit, NMERI pioneered research in coastal engineering in this country. Model tests and research for the layout of Richards Bay harbour on behalf of the South African Railways and Harbours, which included measurements of wave conditions, currents, wind, sand movements, tidal records and flood rates, extended over a period of 3,5 years. Other projects included the Durban harbour, St Lucia estuary and lakes and lagoons in the Knysna area.

When in 1968 the Hydraulics Research Unit moved to the campus of Stellenbosch University a new Fluid Mechanics Division was created in the institute. This division did research on river and dam hydraulics, irrigation problems, hydraulic and pneumatic transportation of solids, as well as flow problems in pipes, valves and ducts.

The facilities and expertise of the institute in this field were used, for example, in a study of the feasibility of transporting some 18 million tons of slimes in slurry form from old gold mine slimes dams on the East Rand to a central retreatment plant for the reclamation of gold, uranium and pyrites. The institute's report on this investigation formed the basis of the engineering design of the pipelines and the pumping system for the mining industry.

The Hydraulics Research Unit in Stellenbosch was combined with the Physical Oceanography Division of the National Physical Research Laboratory in February 1974 to form a new National Research Institute for Oceanology with headquarters in Stellenbosch.

Aeromechanics

The Aeronautics Research Unit was established in 1968 out of the National Mechanical Engineering Research Institute's Aeronautics Division which was formed in 1960. At the time it was envisaged that the unit would fulfil a role as a research and development centre for an emerging South African aircraft manufacturing industry. As an initial aeronautical research project, embracing the unit's main fields of activity – aerodynamics, structures and propulsion – and offering research challenges in each, the concept of an autogyro as a short take-off and landing machine (STOL) was adopted, mainly as a training exercise for new recruits. An experimental prototype was successfully flown in 1973, the project having provided engineers and technicians with practical involvement in the major fields of aeronautical engineering. One of the results of this project was the development of the design and manufacturing techniques for producing helicopter main and tail rotor blades in glass and carbon fibre reinforced composite material, offering a significantly improved structural performance as well as a lower cost by comparison with imported metal blades. Another project concerned the development of a method of assessing aircraft noise disturbance in areas surrounding airports, which was accepted by the provincial authorities as a basis for planning township development in such areas and by the International Organization for Standardization as a basis for revising the relevant code of practice.

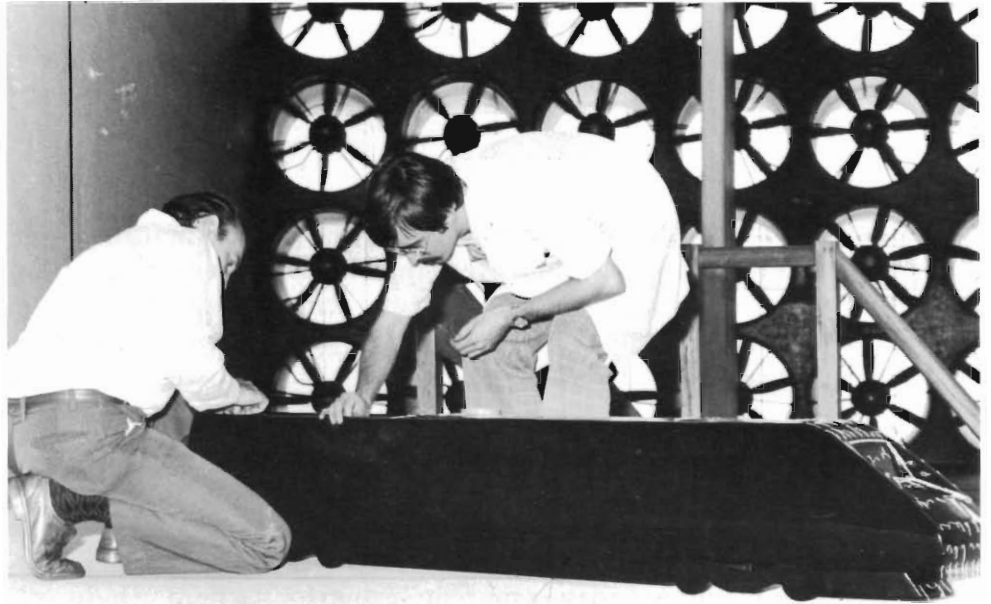
In 1978 the work of the Aeronautics Research Unit was combined with other research activities into a new organization – the National Institute for Aeronautics and Systems Technology with Dr T J Hugo as director. However, research in the general field of non-aeronautical aeromechanics was continued by a new Aeromechanics Division within the National Mechanical Engineering Research Institute.

For this purpose a wind tunnel with a working section of 7,5 metres by 6,5 metres was erected. This facility proved to be invaluable in investigations of the effects of wind forces on slender buildings and structures such as masts

*Hydraulic
transportation of
materials*

Wind resistance

Inside a wind tunnel erected at the Aeromechanics Division, National Mechanical Engineering Research Institute, for investigating the effects of wind forces on vehicles and structures.

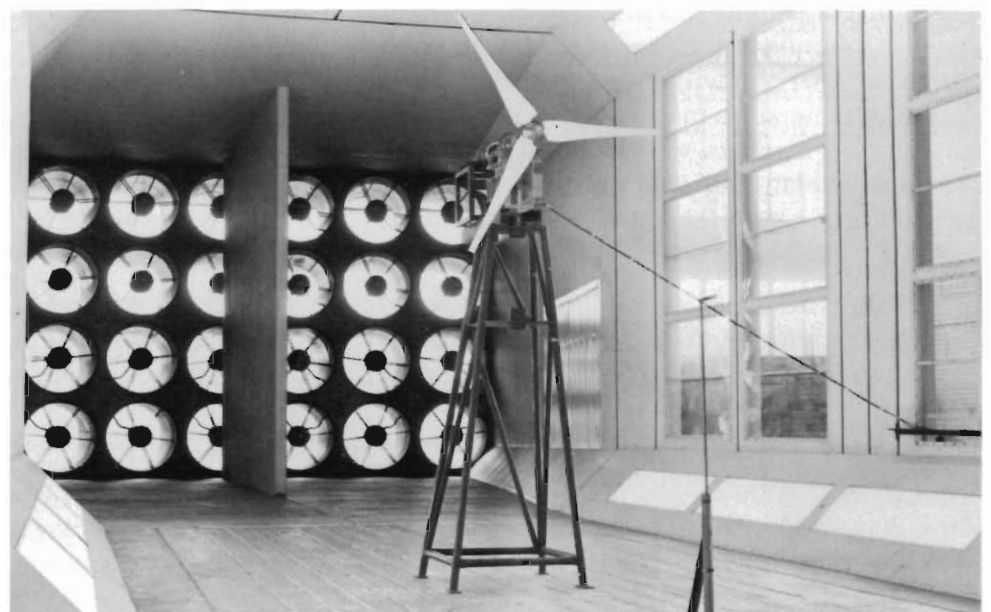


and power lines, the wind resistance of road and rail vehicles, the dispersion of smoke palls and similar problems. The tunnel itself represented a noteworthy development as it differed from the conventional designs of large tunnels, in which the airflow is produced by one or two large fans with variable speed drive; they are expensive, complex pieces of equipment. This tunnel, on the other hand, used an array of 28 ordinary industrial fans, the combined cost of which was a fraction of that of the conventional blowers. The tunnel's air speed, capable of attaining 110 km/h, could be controlled simply but effectively by switching fans on and off in predetermined combinations.

Windmill design

The energy crisis of the 1970s stimulated interest in power generation by means of wind turbines. The windmill or wind turbine is, of course, an age-old and well-tried machine, but theoretical studies indicated that conventional windmill blades did not necessarily have the most efficient aerodynamic shape. A programme for the development of wind turbines for

A wind turbine being tested in the CSIR wind tunnel.



generating electricity was launched by the NMERI, the first phase of which was the development for a client of a small wind turbine made from composite materials and generating 1 kW in a wind of 10 m/s. Tested in the 7-metre wind tunnel, this turbine was found to satisfy the design requirements. In 1980 it was reported that it was already being manufactured by the client and that development of a larger wind turbine generating 5 kW in a wind speed of 10 m/s was contemplated.

Heat mechanics

Under the climatic conditions prevailing in southern Africa, air-conditioning of the working space is desirable to enhance comfort and hence efficiency. As an aid to architects and consulting engineers in the design of air-conditioning and refrigeration requirements, climatic data were analysed by the Heat Mechanics Division of the NMERI and design data for air-conditioning systems were published in the form of charts of southern Africa.

With the adoption of SI units, the design data had to be changed from British thermal units and at the same time an effort was made to take topography into account. As an additional aid to engineers involved in the design, selection and evaluation of air-conditioning systems for proposed installations, a computer program was developed for computing the hourly cooling or heating load caused by solar radiation through windows, heat transmission through external and internal walls and the roof, as well as the load caused by occupancy, lighting, infiltration and ventilation. This program has been used extensively by South African consulting engineers. A solar energy air-conditioning system was also developed and evaluated.

The effect of environmental conditions such as temperature, humidity and air velocity on the quality of meat during chilling was intensively investigated in close collaboration with the Livestock and Meat Industries Control Board and the Division of Veterinary Services of the Department of Agricultural Technical Services. Tests were carried out in experimental cold rooms that were specially designed by the NMERI to study correct chilling, storage and freezing procedures for meat. Special measuring devices were developed to record accurately moisture losses and heat-loss rates from carcasses during chilling. The requirement of the South African Hygiene Act that carcasses should be chilled to a deep bone temperature of 7°C (adopted from the European Community Hygiene Regulations) was questioned, as compliance with this requirement would require chilling for two days instead of one day as in the past, and thus doubling the cold storage area needed. This became a further aspect of collaborative investigation with the Veterinary Research Institute at Onderstepoort and resulted in the publishing in 1982 of guidelines for the chilling of meat for local consumption.

Materials and rock mechanics

Another field of research which was virtually pioneered by the NMERI in South Africa was rock mechanics (now usually referred to as geomechanics), a relatively new field of science which had only recently been applied to practical problems. The institute initially became involved in investiga-

Air-conditioning

Refrigeration and cold storage

*Rockbursts and
strata control*

tions into the problems associated with rockbursts and strata control in gold mines. Internationally recognized contributions to the understanding of fracture and deformational behaviour of rock resulted from this work. Equipment and methods for the determination of stress in rock were developed; for example, a device called the 'doorstopper' and triaxial strain-cells provided convenient means for determining stresses in rock in mining and civil engineering operations. By 1967 the 'doorstopper' and triaxial straincells were being manufactured under agreement by a South African firm for use not only in South Africa but also in Canada, Australia, the USA, Britain, Zambia, Italy and Sweden.

Facilities were also available for determining the strength and other properties of rock as an aid to the design of mining excavations, tunnels, rock slopes and foundations in rock. A portable point-load strength tester was developed and manufactured for use in the field, thereby overcoming the difficulties of bringing rock specimens to the laboratory to determine their strength.

*Design studies for
rock excavation*

By the mid-1970s the institute, which had been in the forefront of rock mechanics research both locally and internationally, was offering a consulting service to civil and mining engineers. Examples of the use which was made of these services included the following:

- Measurement *in situ* of the stresses in the rock surrounding excavations for the Ruacana Power Station, as part of the Cunene River scheme in South West Africa. The results were used by the consulting engineers in designing a support system for the large underground caverns.
- A major investigation, sponsored by the Coal Mining Research Council, into the strength of the unmined coal pillars left to support colliery workings, was completed in 1974. The results, which were obtained by measuring the strength of the pillars in various collieries, threw light on

A scientist taking readings from instruments measuring changes in stress ahead of an advancing face in a deep mine.



the minimum size of pillars which can safely support the workings. This provided a guide to colliery engineers at a time when world energy problems had focused attention on the need for maximum coal extraction.

- At the request of Escom a study was undertaken in 1971 to determine the feasibility, from a rock mechanics point of view, of excavating the large caverns required for the underground power station in the Drakensberg as part of the Tugela-Vaal Scheme. From the information obtained from a site exploration programme, it was concluded that excavation of the underground caverns would be feasible if special attention was paid to the shape of the excavations, and if the rock reinforcement together with the construction method and the excavation sequence were carefully designed. On this basis Escom decided to proceed with the scheme.
- In 1975–76 a similar site exploration programme was undertaken at the request of Escom for the Elandsberg pumped storage scheme near Tulbagh. The work included test tunnels and enlargements, rock mechanics tests in the field and in the laboratory, assessment of the rock mass, provision of design parameters for tunnels and caverns, and design recommendations for the spacing, shape, reinforcement and construction sequence of the various excavations. The total cost of the design study, including excavations, was only 2,5 per cent of the estimated civil engineering costs of the scheme. However, because the rock conditions were accurately determined, the element of risk was reduced and the contractors' allowance for 'unforeseen circumstances' could be reduced.

In the general field of manufacturing technology, the institute dealt mainly with the development of mechanical engineering processes and techniques and the improvement of machinery, plant designs and materials used in industry.

As a result of discussions between the Chamber of Mines, the Government Mining Engineer and manufacturers of steel wire ropes, it was decided in 1964 to establish a Mining Equipment Research Unit within NMERI. Agreement was reached on taking over the buildings and facilities of the Government Mechanical Laboratory at Cottesloe for this purpose. The unit also took over responsibility for statutory testing of winding ropes for the mines in South Africa.

Because of the great depth of many mines in South Africa, problems that are peculiar to this country are experienced with the design of steel winding ropes. To ensure that the ropes used were suitable for local conditions, research was undertaken at the Mine Equipment Research Unit on behalf of a manufacturer of winding ropes in South Africa. For example, a device was developed to register and count the incidence of individual wire failures during the fatigue testing of multistrand mine hoist ropes. The high quality of locally manufactured ropes is recognized internationally and many are exported, mainly to African countries but also to South America and Australia.

Research on foundry technology was started in the early 1960s in collaboration with the South African Foundry Foundation, and the industry assisted

Mining Equipment Research Unit

Facilities for strength testing samples of mine hoist ropes at the Mining Equipment Research Unit at Cottesloe. The insert shows a number of wires tested to destruction.



Foundry sands

in financing and directing the projects. Studies of the moulding materials used in South African foundries, extending over many years, were consolidated in a manual entitled *Properties of some South African moulding sands*. Made available to the industry in 1978, this manual contained data sheets featuring information on properties such as grain size, green strength and permeability of silica sands available from various suppliers in South Africa. It described the tests required to determine these properties and discussed their significance in foundry practice with a view to maintaining and improving the quality of castings. In 1982 the institute brought out a manual on the properties of bentonites and other bonding clays used in foundries. The data presented were compiled from the results of tests carried out in the institute and monitored by a panel representing the South African Institute of Foundrymen.

Alternative fuels

In 1979 a research programme on diesel fuels was undertaken to investigate possible alternative and supplementary fuels for internal combustion engines. The substances evaluated were ethyl alcohol (ethanol), methyl alcohol (methanol), sunflower oil and petrol. Sunflower oil, in particular, showed no miscibility problems with diesel fuel and even the use of pure sunflower oil produced satisfactory short-term engine performance. This finding was followed by an in-depth investigation with the Department of Agricultural Technical Services, despite the disadvantage of its relatively limited availability and high cost as an alternative fuel. The institute, in collaboration with the National Electrical Engineering Research Institute, also became involved in determining the overall transmission and regenerative efficiencies of hydrostatic transmissions for use in electric vehicles.

In addition to research in fields such as the influence of strain rates and impact loading on the deformation behaviour of metals, the impact properties of metals, and the effect of additives on cast iron, the institute provided a service to South African industry by investigating the causes of failure in service of machine and structural components. In 1972, for example, it was reported that of the 83 failures investigated during the previous seven years, 26 were caused by fatigue, 20 by manufacturing faults, 19 by material faults, 12 by corrosion and six by excessively severe service conditions.

Dr M S Hunt became director of the National Mechanical Engineering Research Institute when Dr H G Denkhaus retired at the end of 1980. Dr Hunt, who joined the Institute in 1971, had been responsible, among other things, for research on composite materials for high-duty applications and had opened up a new field of research into the use of carbon-fibre reinforced composites for surgical implants. Two products of this research, known as the 'bollard and toggle', form part of a ligament repair kit which has been marketed worldwide. Work has continued on the development of other prostheses based on carbon-fibre reinforced polysulphone.

In 1983 the Metal Mechanics Division of NMERI was moved to the newly created National Institute for Materials Research of the CSIR and was replaced by a Tribology Division to deal with friction, lubrication and the mechanics of mating surfaces, and a Design and Development Division.

In October 1984 a unit of the CSIR's Technical Services Department, the Production Engineering Advisory Service, was transferred to NMERI. This enhanced the linkage between the institute and the local metals engineering industries.

In 1985 the Institute was organized into the following divisions and units: fluid mechanics, aeromechanics, heat mechanics, geomechanics, strength mechanics, tribology, design and development, mine equipment research, and a production engineering advisory service.

Over the years, NMERI played an important role in the advancement of the technological status of the local engineering and mining industries. About a quarter of its total annual budget came from direct services to industry, the other three-quarters being obtained by parliamentary grant for conducting research on programmes of general importance to the well-being of industry in general and the national economy as a whole.

DEFENCE RESEARCH

In the late 1950s, Dr Meiring Naudé recognized the need for South Africa to develop its own capabilities in those aspects of science and technology associated with modern weaponry and in particular guided missiles. His recommendations to the relevant authorities led to the establishment, within the framework of the CSIR, of the National Institute for Rocket Research and Development in 1963 with Dr J P A Lochner as director, and eventually to the establishment of the National Institute for Defence Research in 1965 with Dr T J Hugo as director.

From its inception this institute derived its finances from research and development contracts undertaken on behalf of the Department of Defence and associated industries which accordingly retained a proprietary interest in the resulting technological developments. As part of the process, advanced technology, with the staff concerned, was transferred as occasion demanded to South African industries in fields such as guided missiles, dedicated computers and aircraft.

In 1978 the relevant facilities and some members of staff were transferred to Armscor where a new subsidiary, Kentron (Pty) Ltd, was created. Other members of staff with facilities were combined with the Aeronautics



Dr M S Hunt
Director, National Mechanical
Engineering Research Institute,
from 1981
(Chief Director from 1983)



Dr T J Hugo
Director, National Institute for
Aeronautics and Systems
Technology, from 1977
(Chief Director from 1983)

Research Unit of the National Mechanical Engineering Research Institute to form the already mentioned National Institute for Aeronautics and Systems Technology (see page 161), with Dr T J Hugo as the director.

OCEANOLOGY

Although South Africa's early history is bound up with the sea, the trend of development was inland and coastal and maritime resources were somewhat neglected. In the 1920s, however, a marine biological survey started by Professor J D Gilchrist of the University of Cape Town gave great impetus to the study of the surrounding oceans. His findings resulted in the establishment of the Division of Sea Fisheries of the Department of Commerce and Industry in the 1930s. Although the main interest was in sea fishing and whaling, studies in physical oceanography were an essential feature of marine biological surveys.

The CSIR became involved in marine activities as early as 1954 when a small physical oceanography unit of the National Physical Research Laboratory was set up in Cape Town. Based originally in the Department of Electrical Engineering of the University of Cape Town and later at the SAS *Unitie* at Cape Town harbour, this unit was concerned with the measurement of sea temperatures down to depths of 30 metres, the velocity of sound waves in sea water and the development of apparatus for recording these parameters. The work was aimed primarily at determining the effect of turbulence in the surface layer of the ocean and on the acoustic detection of submarines by surface ships.

International Geophysical Years

During the International Geophysical Years (IGY) 1957–58, the unit collaborated with the Department of Electrical Engineering of the University of Cape Town in operating a water velocity and swell measuring unit near Witsandbaai on the west coast of the Cape Peninsula and also in recording long waves by means of Van Doorn (Tsunami) recorders.

Along with other bodies, such as the Division of Sea Fisheries and the South African Naval Hydrographic Office, the CSIR's Physical Oceanography Unit provided routine physical oceanographic data to the world data centres set up for the IGY. During this period oceanographic and Antarctic research vessels from Russia, Japan, the USA, Britain, Germany and France called at Cape Town and the scientists visited some of the local IGY stations. The South African Government also made available the frigate *Vrystaat* to accompany the oceanographic research vessel *Vema* of the Lamont Geological Observatory of Columbia University, New York, in carrying out a planned set of seismic profiles off the South African coast. This provided an opportunity for South African scientists to work together with scientists from the Lamont Observatory.

Marine disposal of effluents

In the meantime there was growing concern about the discharge of sewage and industrial effluents into the sea. Pollution of the sea along the Natal coast, resulting from the discharge of sewage had serious implications - not only for coastal resorts, where an estimated R40 million was being spent annually by holiday-makers, but also for established industries, in which several hundred millions of rands had been invested. Because of the

urgency of the problem on the Natal South Coast and the lack of factual information, the Natal Provincial Administration took the initiative by providing funds for a preliminary investigation by the CSIR. For this purpose the CSIR organized a co-ordinated research project involving four of its research institutes – the National Mechanical Engineering Research Institute (Hydromechanics Division), the National Institute for Water Research (which had taken the lead in starting these studies), the National Building Research Institute (the design of pipes for marine outfalls), and the National Physical Research Laboratory, which transferred its physical oceanography unit from Cape Town to Durban for the study. Local bodies involved were the Oceanographic Research Institute of the South African Association for Marine Biological Research in Durban and the Durban Corporation. Additional financial support was provided by an industrial undertaking, South African Industrial Cellulose Corporation, and by the Natal South Coast Bathing Safety Association.

These investigations on Natal coastal conditions dovetailed with investigations into another major problem which had received the attention of coastal authorities in Natal for some time, namely the movement of sand along the Durban coastal area, and how it influenced the siltation of the harbour entrance and the sand coverage of the beaches. The interested parties combined with the CSIR in planning an extensive model test, based on the information derived from studies of the weather, wind and current distribution and wave formation in the Durban area. The model was developed by the Hydromechanics Division of the National Mechanical Engineering Research Institute.

The contribution of the Physical Oceanography Division was limited by the lack of an appropriate vessel to provide a 'floating platform' from which the required measurements could be made. This was rectified with the commissioning in May 1968 of the CSIR's own research vessel – the *Meiring Naudé*.

Harbour siltation

Research vessel *Meiring Naudé*



The Research vessel
Meiring Naudé.

Designed and built in Durban, this ship (length 31,75 m, draft 2,97 m, beam 7,62 m, range 2 000 miles and endurance 10 days) is equipped for multidisciplinary oceanographic work (with wet laboratory, electronics laboratory and biological/chemical laboratory) and can accommodate eight scientists/technicians and a crew of 13. An important feature is an anti-roll tank which reduces the roll of the ship to less than five degrees in six-metre waves.

The Agulhas Current

By 1970, regular current measurements in the vicinity of Durban had revealed the consistency and magnitude of flows within the Agulhas Current and had also shown the meandering nature of the current, the inner or landward edge of which was at times displaced eastward by up to 50 km from its closest inshore position. It was postulated at the time that this meandering and the accompanying variable nature of the inshore counter-current were linked to the passage of coastal lows equatorward along the Natal coast. In view of the planned harbour development at Richards Bay, a programme of intensive physical studies was undertaken in that area.

In the late 1960s the growing demand for applied research in coastal engineering, arising mainly from the projected major harbour developments at Richards Bay and Saldanha Bay, created the need for a suitable laboratory capable of housing large hydraulic models. It was decided that a specialist group should be formed to undertake the necessary studies, and in 1969 the Hydraulics Research Unit of the National Mechanical Engineering Research Institute was formed. This was housed in a new building with a large models hall which was built near the Engineering Faculty buildings of the University of Stellenbosch to facilitate close collaboration with the university in research on coastal engineering and hydraulics.

National Institute for Oceanology

In 1974 the various activities of the CSIR in the marine sciences, with their facilities, were combined in a new National Research Institute for Oceanology (NRIO) with its headquarters in Stellenbosch. These were the Physical Oceanography Division of the National Physical Research Laboratory with its research vessel in Durban, biological/chemical marine pollution research supported by the CSIR at the University of Cape Town, and the Hydraulics Research Unit of the National Mechanical Engineering Research Institute with its buildings and laboratories in Stellenbosch.



Professor E S W Simpson
Director, National Research
Institute for Oceanology, 1974-1976

At the official opening of the new institute in Stellenbosch on 13 August 1974, the then Minister of Planning, Mr J J Loots, emphasized the importance of research in oceanology for South Africa with its 3 000-km coastline facing three oceans – the Indian Ocean, the Atlantic Ocean and the Southern Ocean. He also referred to the international character of oceanology and to the role played by the South African National Committee for Oceanographic Research (SANCOR) (see p.74) in co-ordinating activities on a national level and maintaining links with international research in this field.

Professor E S W Simpson, a leading marine geologist, became the first director of the new institute. Two years later, when Professor Simpson assumed the chair of oceanography at the University of Cape Town, he was succeeded by Mr F P Anderson who had been responsible for physical oceanography since its inception in the NPRL in 1954.

From 1974 the Natal Regional Laboratory of the CSIR's National Institute for Water Research (NIWR) had been working in collaboration with the NRIO in an extensive survey of pollution in estuaries, beaches and the sea along the South African coast. The NIWR was responsible for the east coast region from Kosi Bay in the north to the Buffalo estuary at East London in the south. This survey formed part of an international marine pollution monitoring programme.*

In 1979, an Estuary Research Unit was established at the NRIO to review all existing information on river mouths and estuaries of the Cape Province, from the Kei to the Orange River, for use by the relevant authorities in formulating a cohesive management policy for the South African coast. This unit was also responsible for identifying gaps in existing information and formulating research programmes (to be undertaken by universities or other research organizations) to provide the required information.

To meet the need for effective management of the data and information generated by the many organizations involved in marine research around the extended South African coast and surrounding oceans, the executive committee of SANCOR decided in August 1977 to establish a South African National Data Centre for Oceanography, to be administered by NRIO as a national facility. The preliminary work was undertaken in 1978 by Dr S Borg, then librarian of the NRIO. This included surveying and assessing the available data, the needs of potential users and the procedures of similar data services in Europe and the USA. For the latter purpose, data centres in Europe were visited.

In that first year, a start was made with collecting and processing physical/chemical data. Fortunately, assessing these data presented no serious problems. In this the centre was greatly assisted by the World Data Centre in Washington DC, which provided tape copies of South African physical/chemical data, prepared and deposited there in 1968 by Dr Peter Duncan of the Physical Oceanography Division in Durban (at that time part of the CSIR's National Physical Research Laboratory). However, preparing the information for computer input and programming for computer processing for retrieval in a variety of forms to meet a diversity of user needs presented greater problems. These were eventually overcome by a gradually augmented professional staff, initially with assistance from the University of Stellenbosch. Operation of the centre was greatly facilitated when, in August 1978, the NRIO was linked to the CSIR's CDC computer in Pretoria. In January 1982 the centre was renamed the South African Data Centre for Oceanography (SADCO).

By 1985, SADCO had set up a series of interrelated data bases containing about 800 million words of information covering physical, chemical, climatological, biological, pollution and other disciplines as well as related information such as cruise, project and satellite inventories. By that time data extraction was being supplemented by a wide range of software products to derive statistical information, graphical representation and



Mr F P Anderson
Director, National Research
Institute for Oceanology, from 1976
(Chief Director from 1983)

*SA Data Centre for
Oceanography*

* The group responsible for this marine pollution work was later transferred to the NRIO, operating as a Durban-based branch of the institute.

other specialized analyses. About 300 indirect requests a year were being received by letter or telephone from local users and from countries such as Britain, the United States, Germany, Portugal, Japan, Taiwan and India. In addition, about 3 000 requests a year (10 a day) were being dealt with directly for on-line users with access to the South African Post Office network (Saponet) or the CSIR network by leased or dial-up lines, with extraction being facilitated by a comprehensive menu system. Users of this service included CSIR institutes, the Institute for Maritime Technology, the Sea Fisheries Institute and Rhodes University, with one on-line user from the United States.

The following brief review of some of the major achievements of the institute provides an indication of the range and scope of the research activities which were developed in a relatively short period.

Considerable progress was made in understanding the offshore currents around the African subcontinent. Data obtained on the flow and variability of the Agulhas Current established that with a flow of $70 \times 10^6 \text{ m}^3/\text{s}$ it ranks as one of the major currents of the world.

Knowledge of the current structures and wave energy is of great significance not only to shipping but also in such matters as the discharge of effluent from land into the sea. Wind was found to be a dominant force in the inshore current variability on the wider Natal shelf. Changes in energy experienced by surface waves moving into the Agulhas Current confirmed the existence of a high wave regime responsible for damage to ships.

The institute undertook to gather environmental data on the Agulhas Bank and on the west coast under contract to the Southern Oil Exploration Corporation (SOEKOR) oil drilling programme. Analyses showed the existence of substantial energy in tidal and inertial bands.

The NRIO did pioneering work in the use of satellite-tracked buoys in a study of ocean currents. At first this work concentrated on the south-west Indian Ocean. However, in 1979, in co-operation with the United States, a project for the launching of free-floating buoys in the Southern Ocean was carried out successfully as part of the drifting buoy programmes of the Global Atmospheric Research Programme (GARP). These buoys were tracked by the satellite Nimbus 6, and meteorological and oceanographic data were received for analysis via the satellite.

The CSIR, the University of Cape Town and the Sea Fisheries Research Institute participated in an experiment to study the upwelling of cold ocean bottom water on the west coast and its influence on the productivity of the Benguela Current. This involved five ships, two aircraft and about 70 scientists in a series of validation experiments related to the so-called Coastal Zone Colour Scanner on board the NASA Nimbus 7 experimental satellite, designed to collect data on ocean temperature and colour. Imagery from other satellites (NOAA, TIROS, METEOSAT and LANDSAT series) was used to build up an extensive data set.

In the field of coastal engineering and hydraulics, major projects included:

- Detailed model studies related to the design and development of the Richards Bay and Saldanha Bay harbours.

Data for oil exploration

Coastal engineering



A group of high-school pupils getting to know more about oceanographic research in the hydraulic model hall at the NRIO in Stellenbosch.

The Richards Bay contract, undertaken in 1967, involved coastal investigations such as measurements of waves, tides, currents, river flows, beach profiles, nearshore and offshore bottom profiles and sediment transport conditions. These data were used as input to the hydraulic model studies on the harbour entrance layout, the required entrance channel dimensions, sediment build-up and erosion in and adjacent to the harbour entrance, a new estuary mouth for the southern half of the bay (the nature reserve), flood relief works in the dike separating the harbour area and the nature reserve, and breakwater stability. Uninterrupted records over a period of more than 15 years make Richards Bay one of the best monitored coastal projects in the world. Subsequent studies were undertaken to determine the minimum channel dredging required to make the port accessible to fully-laden 250 000 dwt ships. Other projects involved the following:

- Appraisal of the Durban beach protection scheme.
- Model studies of the Koeberg nuclear power station cooling water intake basin.
- Model studies for the design of the small-craft harbour in Granger Bay, Cape Town, and the fishing harbour at Gansbaai.
- The development of the 'dolos', a breakwater armour unit invented by a former harbour engineer, Mr E M Merrifield, to protect the East London breakwater. In 1964 the harbour authorities asked the CSIR to carry out basic stability tests on dolosse, tetrapods, tetrahedrons and rectangular blocks to determine the effectiveness of the dolos unit compared with other known breakwater armour units. The tests showed that the dolos armour units had greater stability, which meant that these much lighter units could be used with a consequent saving in total concrete volume in armour layers. As a result, dolosse came to be used in harbour works all over the world.



'Dolos' breakwater armour units.

*Environmental
studies*

Multidisciplinary studies involving biologists, chemists, marine geoscientists and coastal engineers (more particularly those with specialized knowledge of hydrodynamics and sediment dynamics) produced valuable information on the marine and coastal environment. Information on a large number of estuaries in the Cape and Natal was published while many *ad hoc* investigations were carried out regarding proposed coastal developments. The background levels of various chemical substances in the Cape coastal environment were determined for the purpose of investigating marine pollution. The institute worked in close collaboration with the Department of Environment Affairs.

In 1984, additional laboratories were completed for the National Research Institute for Oceanology. This provided laboratory space on the institute's campus in Stellenbosch for those staff members who were previously accommodated by the University of Cape Town and the University of Stellenbosch.

Despite the considerable progress made in three decades, much remains to be done to ensure rational development of coastal areas for economic and recreational use and judicious exploitation of marine resources.

TELECOMMUNICATIONS AND RADIOPHYSICS

When planning the CSIR in 1945, Dr Schonland was aware of the need for essential specialized services in the important field of radio communication required by the Departments of Defence, Transport and Posts and Telegraphs, and by the South African Broadcasting Corporation. To expedite the provision of these services, he arranged with the Department of Defence for the secondment, before their demobilization, of a small group from the Special Signals Service which had been primarily concerned with radar and its applications during the war. In this way he was able to secure for the CSIR some of the brightest of those young graduate scientists, engineers and technicians who had volunteered for war service and gained invaluable experience in the relatively new and exciting field of radiophysics.

As the National Physical Laboratory was not yet in existence, he persuaded his council that this activity should be managed as a special project outside the framework of that laboratory. As a result the Telecommunications Research Laboratory was set up in premises provided in the Department of Electrical Engineering of the University of the Witwatersrand. There is little doubt that the considerable success of radar during the Second World War – in particular in the air defence of Britain and the so-called battle of the Atlantic – was one of the main factors that influenced Schonland in his decision to establish the Telecommunications Research Laboratory as one of the founder organizations of the CSIR.

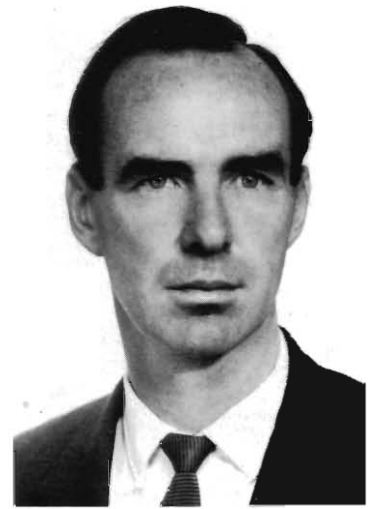
In 1955 the laboratory was raised to the status of a national research institute and its head, Dr F J Hewitt, promoted to director. In 1959 a permanent building in the grounds of the University of the Witwatersrand was completed and occupied and the name changed from the National Telecommunications Research Laboratory to the National Institute for Telecommunications Research (NITR). When in 1964 Dr Hewitt was promoted to vice-president of the CSIR, he was succeeded by Mr R W Vice.

The work of the Telecommunications Research Laboratory was largely concerned with the study of natural phenomena and their effects on radio waves. Its field of operation covered the radiation, propagation and reception of radio waves in all possible media and the use of such radio waves for practical purposes. Telecommunications by means of wired circuits was tacitly excluded as being the field of the Post Office. The projects on which the Telecommunications Research Laboratory was engaged during its early years were the study of the ionosphere and its effect on HF radio wave propagation, ground wave propagation, the measurement of atmospheric radio noise levels, the effect of such radio noise on radio communications and navigation systems, and the use of radar for the study of thunderstorms.

These radio and radar studies of natural phenomena such as the ionosphere, atmospheric radio noise and thunderstorms were greatly facilitated by the strong capability of the Telecommunications Research Laboratory for the development of special instrumentation, for which the wartime experience of all the original staff stood them in good stead. This, in due course, led to the establishment of various programmes in which the development of special instrumentation itself was the sole objective; and such programmes became an important part of the institute's activities.

The ionospheric studies quickly developed into services of practical use. Ionospheric observations were made regularly by the institute from the first year of its existence at various stations in southern Africa, and predictions of HF propagation conditions based on these observations were issued monthly. Later the Johannesburg station was designated a key station in the world network because of its geographical position and its long unbroken record of excellent observations. During the International Geophysical Year (1957–58) and for some years thereafter, studies of the lower ionospheric layers led to an increased understanding of their structure and behaviour and in particular of their absorption of radio waves.

Subsequently the institute extended its capability to predict transmission losses to the VHF, UHF and microwave ranges. Topographical effects in



Mr R W Vice
Director, National Institute for
Telecommunications Research,
from 1964
(Chief Director from 1983)

*National Institute for
Telecommunications
Research*



Dr F J Hewitt
Director, National Institute for
Telecommunications Research,
1955-1964

terrestrial systems and the attenuation due to rain at the higher microwave frequencies, for both terrestrial and earth-satellite systems, were studied. The national antenna test facility at Paardefontein near Pretoria was established and maintained by the Institute to test the performance of antenna systems.

Ionosphere recording

For the ionospheric observations an ionosphere recorder (ionosonde) had to be developed. A more or less conventional approach was adopted to obtain results quickly. Three wavebands with mechanical switching were used, but a new feature was that a complete record could be obtained in under 10 seconds through a panoramic display. This rapid display greatly facilitated visual observations of the prevailing conditions and also made it easy to make a record over 24 hours of conditions observed at minute intervals. Projected at 16 frames a second, such a film revealed in a striking manner the way in which changes in the ionosphere develop. Mr T L Wadley was responsible for this work and for the development soon afterwards of a single-band instrument which simplified the system mechanically and gave the design an exceptional service life. Several of the single-band ionosphere recorders were built and operated in Johannesburg and at the Cape for many years.

The Wadley receiver

The development of this single-band ionosphere recorder led directly to work on a variable frequency crystal controlled receiver covering the HF band. This receiver, apart from the passive preselection stage, involved no band switching, and its stability and frequency setting accuracy constituted advances of international importance in a highly competitive field. This was the famous Wadley receiver which was manufactured under licence by Racal in Britain. By 1959 the receiver was being used by the armed services of a number of countries and by many commercial organizations. The

Dr T L Wadley with the receiver named after him.



complementary device, a variable frequency crystal controlled generator for the control of HF radio transmitters, was also developed. Overshadowed by the success of the receiver it was never commercialised, but as nothing comparable was available elsewhere the SABC and the Post Office built many of them in their own workshops for the frequency control of some of their HF transmitters where slight frequency flexibility was required.

Low-frequency noise measurements by the institute, directed mainly at radio aids to navigation which were under consideration by the Division of Civil Aviation of the Department of Transport, were complemented at an early stage by a detailed survey over South Africa and South West Africa of ground wave propagation conditions in the medium wave frequency regime. This country-wide survey of radio field strengths led to the production of a ground conductivity map from which the ground wave propagation losses at low and medium frequencies could be derived.

The ground wave propagation study was made by measuring the field strengths of all available LF and MF transmissions over the whole region. By concentrating on high sensitivity and selectivity special equipment was designed and built to extend the range at which measurements could be made even in high noise levels. Commercially available equipment was not competitive.

A practical application of the knowledge of atmospheric noise levels and ground wave propagation conditions was the participation of the Telecommunications Research Laboratory in a series of trials of the Decca Navigator System (for aviation) arranged by the Department of Transport. Intended originally as a series of demonstrations and elementary tests, it quickly became obvious that a detailed study of the effect of high levels of radio noise such as is experienced on the Highveld in summer was necessary. The results of the studies, in which the noise records of the institute played a key role, contributed greatly to the recognition by the Decca Navigator Co. of the need for a major redesign of the receiver. For several years thereafter the Institute conducted tests on new models of the receiver under contract with the company and a conspicuous improvement in performance under tropical and subtropical conditions was achieved.

The atmospheric noise recording programme was the work of Mr D Hogg, but the movement simulators required for the tests on the Decca Navigator receivers were suggested and developed by Mr J A Fejer. They were quite essential for the success of the trials as the performance of the Decca receivers of that time deteriorated significantly as the speed of the aircraft increased. As far as is known the use of such simulators for tests of this nature was new.

In retrospect, possibly the most conspicuous feature of the laboratory's work on HF and MF radio wave propagation was that within a few years a good working knowledge was obtained of all the important natural conditions influencing HF and MF propagation – a working knowledge probably as good as that in any other country in the world and far better than most.

This was achieved at a cost that was quite trivial, as the professional staff involved could have been counted on one hand.

Atmospheric noise frequency and ground wave propagation

Underground radio communications

However, the importance of this work was greatly diminished by the advent of the communications satellite towards the end of the 1960s. It is difficult now to imagine how unsatisfactory and unreliable a service was rendered by HF radio, on which most international long distance telecommunication had of necessity to be based at that time.

A challenging investigation was undertaken by the laboratory during its early years in the form of a contract for the Chamber of Mines which called for the development of a radio communications system for use by proto teams in fire fighting and rescue operations underground. With the advent of portable radio equipment such as the walkie-talkie, which became freely available after the Second World War, various people had tried to establish radio communication underground. Usually they were at a loss when they found that this could often not be done, even along a drive with the other party clearly in sight.

To overcome this problem the Telecommunications Research Laboratory made a study of the physics of radio propagation through rock with the use of samples in the laboratory and *in situ* measurements. In this way the optimum frequency region was determined, a compromise between various factors being necessary. Equipment suitable for the type of operation envisaged was developed and a workable system was demonstrated which gave a range of about 600 m under typical Witwatersrand conditions. The equipment met all the specified requirements and was handed over to the Chamber of Mines for development. However, many years were to elapse before this knowledge was applied in practice in the late 1970s, during which time South Africa had lost the chance to be world leaders in this specialized aspect of mining.

Radar equipment for SA conditions

For many years after the Second World War radars suitable for Transvaal Highveld conditions were not available from commercial sources. To fill the gap a radar division was formed in the laboratory under Mr P Meerholz. This group designed and constructed a surveillance radar suitable for South African conditions which was engineered for manufacture by a local firm. Its performance was in line with the state of the art at the time and was even equipped with a parametric amplifier 'front end', to give it a more than five-fold increase in sensitivity over conventional receivers; such devices were not fitted to radars then available from overseas. However, the radar lacked the sophisticated data handling capabilities that were being introduced in countries where multitarget capability was more essential and in due course the Defence Department opted for imported radars. The Institute maintained its interest and expertise in radar, which it applied in the development of radars for specialized purposes.

Tellurometer system of distance measurement

Mention has been made of the strength of the original Telecommunications Research Laboratory in the development of instrumentation for special purposes. This was brilliantly demonstrated by the invention and development of the 'Tellurometer' system of distance measurement which was destined to revolutionize land-surveying throughout the world. The success of radar during the Second World War had given rise to the hope that radar techniques could be applied to speed up the laborious task of geodetic surveying, but success was elusive. From the beginning Colonel Harry



Dr Trevor Wadley demonstrating his 'Tellurometer' distance measuring system to British Prime Minister Sir Harold MacMillan during the latter's historical visit to South Africa in 1960.

Baumann, director of the Trigonometric Survey in South Africa, was insistent that the CSIR should give attention to this problem. He specified an operational accuracy requirement for geodetic purposes of one in a hundred thousand – plus or minus two inches. To establish that there was a real demand for such a device, the president of the CSIR, Dr Meiring Naudé, requested that the appropriate government department should provide sponsorship of £4000 for the proposed project, but this was not forthcoming. In the meantime, because of the persistent urging of Colonel Baumann, Dr Hewitt arranged for Mr T L Wadley to do some preliminary work in this field and in 1954, within two months, he came up with the answer to the problem that had defeated the rest of the world since the end of the war. He demonstrated the feasibility of using a unique microwave system for distance measurement. This invention, known as the 'Tellurometer', was patented by the CSIR, and in a series of tests in Britain met the original specification for geodetic purposes of 1 in 100 000 (1 foot in 20 miles) by a fair margin.

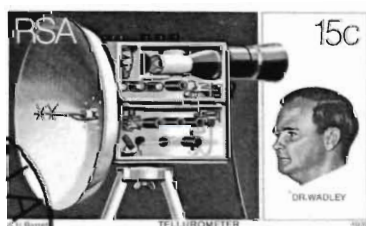
In 1956 a company, Tellurometer Ltd, was formed in Cape Town to exploit the invention and the first production model appeared in 1957. This instrument – light, easy to operate and relatively robust – was being manufactured in Cape Town by Tellurometer Ltd, in association with the CSIR and was in use throughout the world. A symposium in London in August 1962, arranged by Tellurometer UK Ltd, at which there was a large and enthusiastic attendance of users of the 'Tellurometer' system of distance measurement, represented a milestone in the research and development programme of the CSIR in this field. It was recognized that the ability to measure

*Infrared beams for
distance measurement*

distances directly by means of simple radio equipment and accurate enough for geodetic purposes, had revolutionized many aspects of surveying, from the most precise measurements to rapid surveys such as those required for mineral prospecting in civil engineering projects, including road construction.

With the constant development of new techniques which led to improved systems, and with almost unlimited possibilities in the application of radio to land-surveying, the CSIR continued to maintain an active programme of research and development, recognizing that it was only by continued progress that South Africa could maintain its position as the leading supplier of such instruments to meet the world demand. By 1970 research by Mr H D Hölscher into the use of modulated infrared beams for distance measurement resulted in the production, by a South African firm, of a system capable of measuring distances of up to two kilometres to an accuracy of one or two millimetres. The advent of such optical instruments, with an accuracy of about one part in a million, brought with it the need for a standard against which they could be calibrated. In 1971 arrangements were made with the Trigonometrical Survey for the establishment of a standard baseline of 432 metres which was calibrated by optical methods to an accuracy of a fraction of a millimetre as a free service by the Finnish Geodetic Institute. Unfortunately, because of problems associated with the stability of the beacons, this facility could not be used for calibrating distance measuring equipment in South Africa.

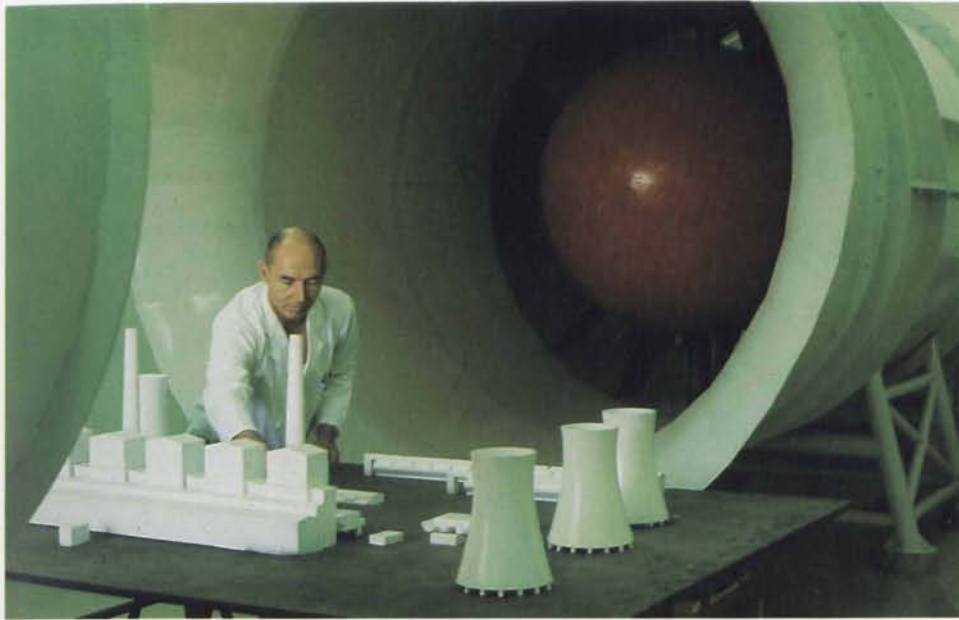
The developments in distance measurement were accompanied by the application of related principles to the development of radio systems for navigation and position fixing over land and sea. Subsequently, recognizing the great potential of satellites in such applications, the institute embarked on a special study of the planned Global Positioning System, including the development of specialized ground equipment.



In 1972 the institute developed a new automatic version of the 'Tellurometer' system in collaboration with its South African producers. After the successful demonstration of the system, the institute co-operated with the firm in the design of a pre-production model. The new system provided for the antenna unit to be separated from the instrument and elevated on a light-weight mast to obtain a clear line of sight over obstructions. Once the instruments were set up, a digital presentation of the distance could be obtained automatically in about 12 seconds. This instrument was later accepted as the NATO standard equipment for distance measurement. In 1979 a special commemorative postage stamp to mark the 25th anniversary of the invention of the 'Tellurometer' system was issued by the South African Post Office.

*Radar studies of
lightning and rain*

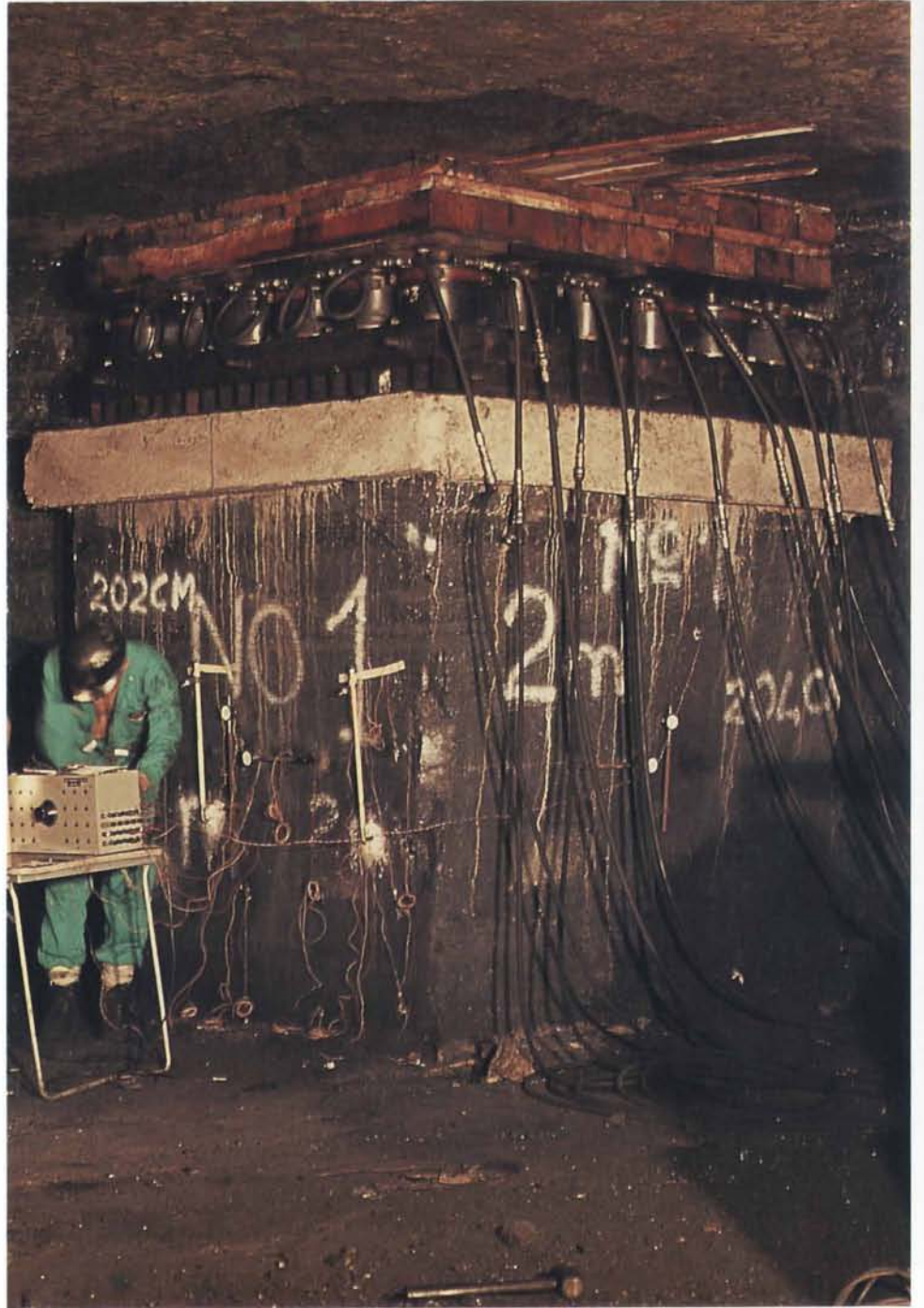
It was realized from the outset that radio and radar could be powerful tools in the investigation of natural phenomena such as cloud, precipitation and lightning. In 1952, Dr Hewitt began a study of lightning which continued into the 1960s and was then taken up by Dr D E Proctor. Hewitt demonstrated that radar could be used to study, in particular, the interstroke processes in ground flashes, and he was the first to record fully time-resolved radar echoes during the interstroke periods. Proctor developed a



Research into the siting of a power station in a windtunnel of the National Mechanical Engineering Research Institute.



Research into foundry sands was conducted by the National Mechanical Engineering Research Institute.



Research into the load-bearing properties of pillars of coal in a colliery was undertaken by the National Mechanical Engineering Research Institute.

unique system of spaced receivers with which he was able to trace the sources of noise with unprecedented spatial and temporal resolution, and to relate the occurrence and position of lightning activity with the precipitation patterns observed by radar.

Early work on the polarizing effects of rain and hail on radio waves was followed by a study of the use of radar in the measurement of rainfall. In 1972 a joint radar facility was established in co-operation with the National Physical Research Laboratory at Houtkoppen, north-west of Johannesburg. This was to be used by the institute for radar measurements of rainfall over a wide area as part of a hydrological investigation into the correlation between rainfall and run-off in a river catchment area. In a more fundamental study, an 8-mm Doppler radar with a high resolution in range and velocity was developed for use in measuring the velocity spectrum (and hence the drop size distribution) of falling raindrops to help the NPRL in its studies of thunderstorm dynamics.

The institute's involvement with space projects began during the International Geophysical Year, 1957–58. The United States Naval Research Laboratory in a project known as Vanguard, envisaged placing a geodetic satellite in an earth orbit as part of the USA's national programme for the IGY.

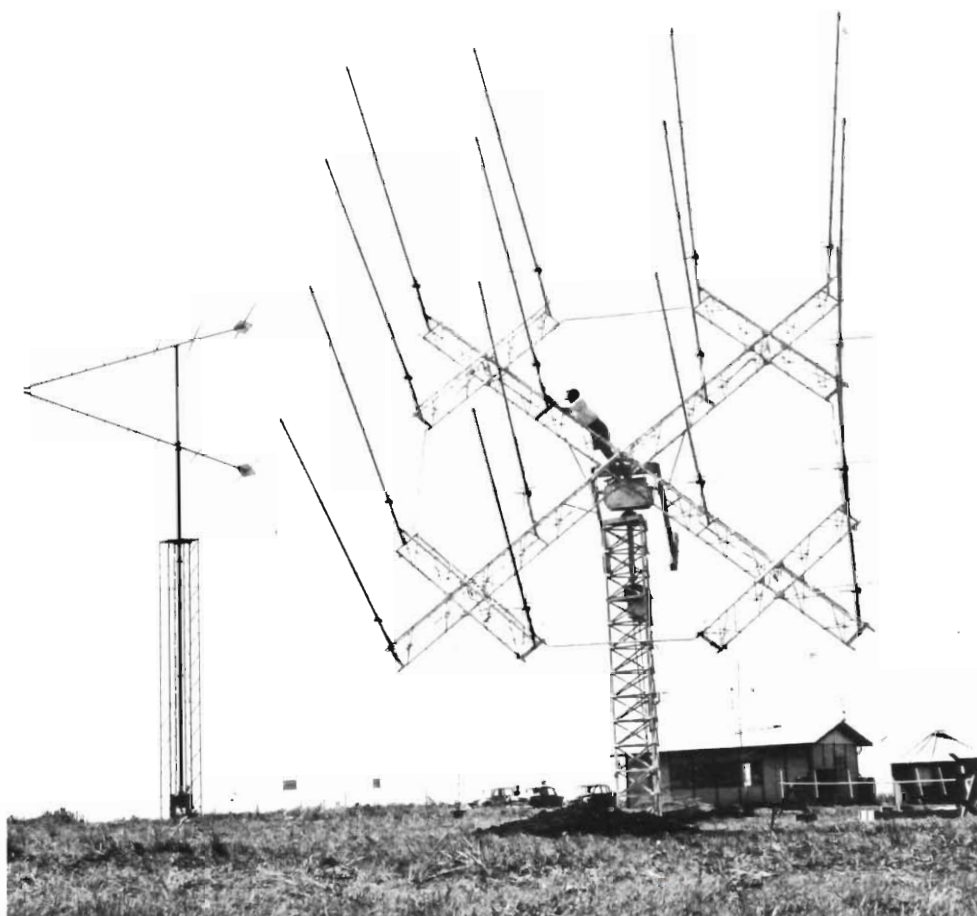
At the request of the South African National Committee for the IGY, the institute accepted responsibility for the installation and operation in South Africa of a precise radio system for tracking artificial earth satellites known as Minitrack. The system was capable of determining the course of a satellite equipped with a suitable radio transmitter to an accuracy approaching that of optical methods, though not restricted by the weather or to dawn and dusk conditions. The installation of this equipment was completed early in 1958 on a site made available by the South African Railways and Harbours at its training college at Esselen Park. One of the reasons for undertaking this commitment was that, because of its geographical position, South Africa could play an important part in early observations of earth satellites and space probes.

While the arrangements for Minitrack were still being negotiated in 1957, the first Russian earth satellite, Sputnik I, was placed in orbit without warning. With hastily assembled equipment, radio signals from the satellite were received and analysed by an NITR team and within a few days the orbit was determined with great accuracy. Shortly afterwards J A Fejer of the NITR published in *Nature* the first accurate estimate to be made of the satellite's lifetime.

From April 1958 onwards the Minitrack station succeeded in tracking all US satellites and space vehicles transmitting on 108 MHz and proved extremely reliable. An ever-increasing amount of telemetry was recorded. The station was originally equipped only for tracking satellites in primarily equatorial orbits. It had a particularly important role as newly launched satellites passed within range of the station about 20 minutes after launching, and thus information from Esselen Park was the first intimation of the success or otherwise of an operation.

*International
co-operation in
space research*

A satellite tracking antenna at the first Minitrack station near Esselen Park.



*Satellite telemetry and
deep space probes*

In 1960 an intergovernment agreement between South Africa and the USA was signed, followed by an interagency contract between the CSIR and the National Aeronautics and Space Administration (NASA) for the establishment and operation of a deep space station in South Africa. The contract also covered the enlargement and upgrading of the existing Minitrack station, which later became known as the STADAN station (Satellite Tracking and Data Acquisition Network). South Africa was conveniently situated in relation to the USA for the tracking of deep space probes, and with two other stations elsewhere in the world continuous observation of a space probe was possible.

*Deep Space
Instrumentation
Facility –
Hartebeesthoek*

The first priority was to select a location free from man-made radio interference; a valley site ensuring no direct line of sight with potential noise sources was required. After an intensive search, an excellent site was eventually found in a valley north-west of Johannesburg and about 30 kilometres north of Krugersdorp. After extensive tests, it was accepted by the Jet Propulsion Laboratory of NASA and the South African Government bought some 500 hectares of land, part of the farm Hartebeesthoek, for the establishment of what came to be known as the Deep Space Instrumentation Facility. The satellite tracking station (Minitrack) was moved from Esselen Park to an adjacent plateau site and the two facilities shared support services such as power and communications.

The site selection was only finalised in late 1960 and the first deep space probe was scheduled for June 1961. This left nine months in which to instal a sophisticated tracking station in a valley uninhabited since the days of the Voortrekkers. The vital task of organizing the construction of roads to the



Deep space probes were accessed and tracked by means of this 26-m dish antenna at Hartbeesthoek near Krugersdorp.

site, of essential buildings and of foundations for the 26-metre parabolic antenna, was entrusted to the CSIR's Estates Department. American contractors erected the antenna, electronic equipment was installed in the control room, a power station was built and communication links to the USA were provided by the South African Post Office. By June 1961 the station was ready to take its place in the deep space network along with sister stations at Goldstone, California, and Woomera, Australia. This station was unique because, on account of its geographical position, it was responsible for the 'acquisition' of new spacecraft launched from Cape Canaveral down the 'eastern test range'. They could be detected some 30 minutes later and the station's job was to establish two-way communication and to obtain early tracking data, command capability and telemetry information. The first successful interplanetary operation was that of tracking the research vehicle Mariner II on its Venus fly past. Subsequently it played a key role in all the American deep space missions, until its closure in 1974.

The satellite tracking station became one of the busiest stations in the world network and earned for itself an enviable reputation for reliability. The performance of all the stations in the network was closely monitored and the South African station was consistently among the top three, often in first place. In 1975, the year before it closed, it operated for an unprecedented 10 months without a single operational error or equipment failure.

In the meantime South Africa had been taking part in an international study of the use of earth resources observation satellites conducted by NASA. The CSIR, the Department of Planning, the Department of Agriculture, the Geological Survey and other bodies participated. Co-ordinated by

*Satellite remote
sensing*

Satellite imagery evaluated

Dr O G Malan of the NPRL, this for some years involved the study of satellite imagery received on film or magnetic tape from the USA to determine their value, for example, in surveys of vegetation boundaries and plant growth, land usage, soil types and geology. Some of the images of South Africa returned by this satellite (which was renamed Landsat) were collated by the NPRL and published in the form of an atlas. This exercise demonstrated the applicability of these data to development studies in southern Africa, and emphasized the desirability of direct access to satellite remote sensing data.

Direct access to Landsat and Meteosat

To make such direct access possible, an agreement was concluded with NASA according to which the CSIR was allowed to operate its own ground station and so obtain data from the Landsat series of satellites. At the same time the need of the Weather Bureau for the direct acquisition of meteorological data from the proposed geostationary weather satellite, Meteosat, became apparent and funds were provided by the Treasury for a combined Landsat/Meteosat receiving station to be operated by the NITR. This was established at Hartebeesthoek making use of major equipment remaining after the closure of the NASA tracking station. This was the first example of a station combining these two facilities in the world. Mr W J Botha was responsible for the definition of the technical facilities required as well as for their installation and subsequent operation.

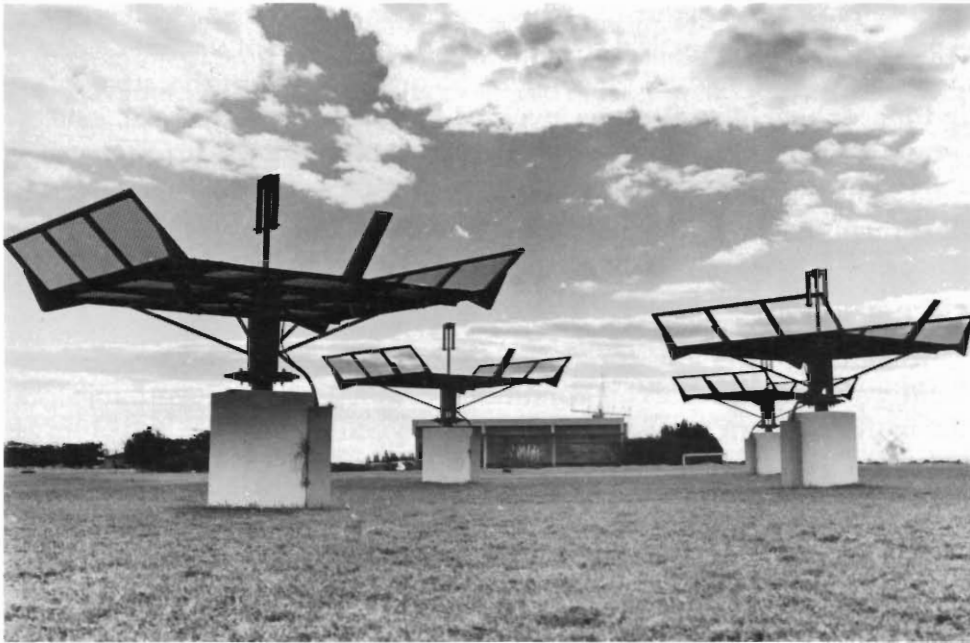
Meteosat data were processed and transmitted by landline to the Weather Bureau in Pretoria for use in weather forecasting. Infrared data from this satellite was also used in studies of current systems in the oceans surrounding South Africa and of the economically important phenomenon of upwelling water off the west coast.

The reception and processing of data from the Landsat series of satellites became a major programme. In terms of an agreement with the United States National Oceanic and Atmospheric Administration the station was recognized as a regional centre for Landsat data receiving and distributing imagery covering most of Africa south of the equator, both locally and abroad. The data proved to be useful in studies of renewable and non-renewable resources in fields such as geology, mineral searches, agriculture, forestry and land use.

Co-operating with French space agency (CNES)

In 1966, in terms of an agreement between the South African and the French Governments, the Centre National d'Etudes Spatiales (CNES) established a satellite tracking station at Paardefontein and the CSIR was appointed the co-operating agency to provide and execute the supporting services stipulated in the agreement. Two years later the agreement was extended to provide for the use of the station as a CNES site for launching scientific balloons and in 1973 it was agreed that the NITR should manage and operate the station.

In 1980 the CSIR entered into a new agreement with the CNES by which the activities of the station at Paardefontein were transferred to Hartebeesthoek and integrated with those of the Satellite Remote Sensing Centre. The centre was suitably equipped and became operational in this additional role at the end of 1982, and played an important part in a number of CNES tracking missions.



Satellite tracking antennae at the CNES tracking station at Paardefontein in the northern Transvaal.

From 1963 to 1974 the NITR carried out a limited programme of radio astronomy at Hartebeesthoek making use of the 26-metre parabolic antenna at the Deep Space Station when it was not required for space tracking. This was done with the full approval and indeed encouragement of NASA's Jet Propulsion Laboratory. Auxiliary equipment operating at a wavelength of 13 cm was designed and constructed by the institute and modifications were developed to extend the operation to 7 cm. The major continuing programme was the measurement of the intensity variations in extragalactic sources.

With the closure of the Deep Space Station in 1974, the antenna became fully available for radio astronomy and in 1978 it was decided to develop the facility as a radio astronomical observatory under Mr G D Nicolson.

Not only did this allow for the continuation and expansion of the institute's programme of radio astronomy but it provided a national facility to which other bodies such as the universities could have access. This facility also made the distribution of observatories in the southern hemispheres more complete, and the Radio Astronomy Observatory at Hartebeesthoek (as it came to be known) co-operated in a number of co-ordinated astronomical programmes, thereby helping to achieve unbroken coverage in the study of astronomical objects of varying intensity.

The observatory is ideally situated for VLBI (very long baseline interferometry) experiments in collaboration with stations in Europe, the USA and Australia, as it provides both north-south and east-west baselines. Initially directed at obtaining very high angular resolutions for the study of fine structures, VLBI offered an immediate practical application in the field of geodesy in the measurement of long distances on the earth's surface with extremely high accuracy.

Radio astronomy



Dr W S Finsen
Director, Union Observatory
(renamed Republic Observatory in
1961), 1957-1965

Republic Observatory

A picture of the earthlit moon
taken by astronomers at the
Republic Observatory in
Johannesburg.

And so this institute which had been set up in 1945 with a small group of experts to provide practical services based on a study of the interaction of radio waves with natural phenomena occurring in the earth's atmosphere and ionosphere, also became involved in radio space research, satellite remote sensing and radio astronomy. It was thus fitting that in October 1975 it should move to new laboratories situated on the site in Johannesburg formerly occupied by the Republic Observatory (see p. 33).

ASTRONOMY

Astronomy has always featured prominently in science in South Africa. The country's excellent observing conditions, coupled with its favourable location in the southern hemisphere, induced several universities and observatories in Europe and the United States to set up observatories here. The Royal Observatory was established in Cape Town in 1820 and was the first scientific institution in the country.

Direct South African participation in astronomy was limited to the Republic (formerly the Transvaal, and then the Union) Observatory in Johannesburg which concentrated on double star and minor planet work. The Republic Observatory was also the official body for the maintenance of the national time service, but for many years it shared this function with the Royal Observatory. For reasons of geographical convenience both observatories sent automatic time signals every hour to the Post Office and to the South African Broadcasting Corporation.

In April 1964 the Republic Observatory, which until then had been managed by the Public Service, was taken over by the CSIR. The director, Dr W S Finsen, was seconded to the CSIR staff and, on his retirement in 1965, Mr J Hers was appointed acting director.



The CSIR, under the leadership of Dr S M Naudé, felt strongly that direct participation of South Africa in astronomical research should be increased and that South African astronomers should engage in modern astrophysical research with the most advanced equipment possible. It was obvious, however, that observing conditions were steadily deteriorating at the existing observatories, namely the Republic Observatory in Johannesburg, the Royal Observatory in Cape Town, the Radcliffe Observatory at Pretoria, and the Boyden Observatory at Bloemfontein, which were all in or near large towns where smog and city lights affected observation.

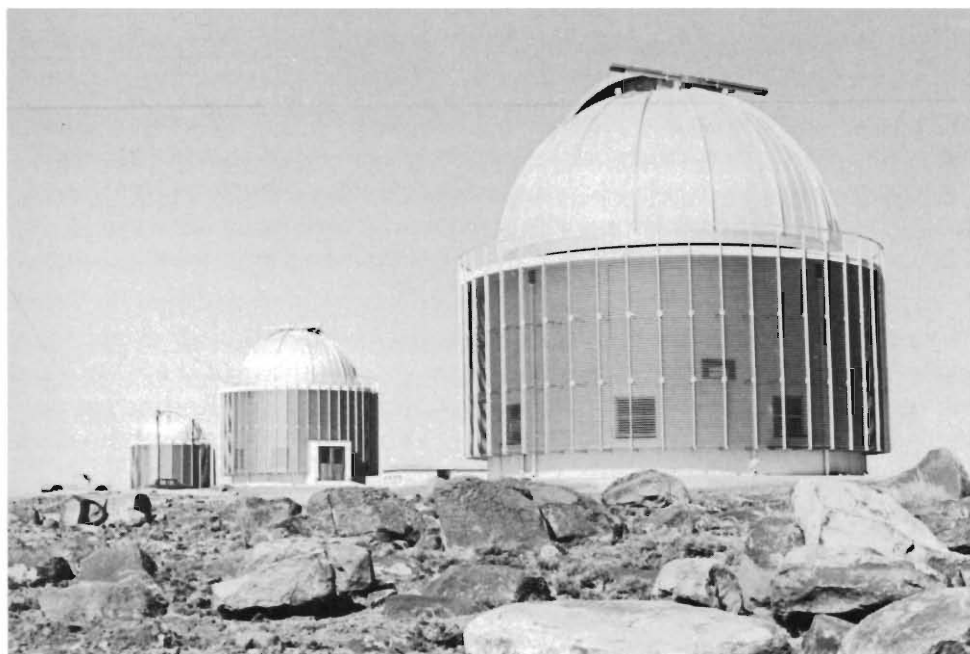
While the CSIR was considering steps to be taken to revitalize South African astronomy, the British Science Research Council in the late 1960s suggested a joint venture in astronomy. From this approach evolved the South African Astronomical Observatory (SAAO) which combined the functions and facilities of the Royal Observatory and the Republic Observatory. The telescopes were moved to a magnificent observing site near Sutherland in the Karoo and the premises of the Royal Observatory in Cape Town were retained as the headquarters of the SAAO. The new institution was established in January 1972 with Sir Richard van der Riet Woolley (until then Astronomer Royal and director of the Royal Greenwich Observatory) as the first director. Even before Sir Richard's arrival, work on the development of the Sutherland site had been started by the Estates Department of the CSIR with Mr G A Harding, of the British Science Research Council and formerly of the Royal Observatory, Cape Town, acting as the senior astronomer on behalf of the CSIR. At this stage the responsibility for maintaining the national time service was transferred to the National Physical Research Laboratory of the CSIR.

In 1972 much of the effort of the SAAO was devoted to commissioning the Sutherland station. Three telescope domes and a technical services building



Sir Richard van der Riet Woolley
Director, South African
Astronomical Observatory,
1973-1976

*South African
Astronomical
Observatory*



Telescope domes at the Sutherland
Observing site of the South African
Astronomical Observatory.



At the official opening of the SAAO observing station, Sutherland, 1973. *Left to right:* Dr C van der Merwe Brink, President of the CSIR; Mrs Margaret Thatcher, British Secretary of State for Education and Science; Mr B J Vorster, Prime Minister; Mr J J Loots, Minister of Planning and the Environment; and Sir Richard van der Riet Woolley, Director, SAAO.

Sutherland observing station

were built, the latter consisting of offices, small laboratories, library, workshops and living accommodation for the superintendent and visiting astronomers. By the end of the year two telescopes had been commissioned - the 0,5-metre instrument formerly used in Johannesburg and the 1,0-metre reflector from Cape Town.

In 1974 the CSIR bought the 1,9-metre reflecting telescope of the Radcliffe Observatory in Pretoria, from the Radcliffe Trustees. This Observatory was founded in 1771 in Oxford, England, transferred to South Africa in 1937 and moved to Australia later. Dismantling of the telescope began towards the end of the year and by the end of 1975, the renovated and significantly improved instrument was moved to Sutherland. This fine telescope, the largest in South Africa, added much to the importance and prestige of the Sutherland observing station.

On 1 March 1973 the SAAO was formally opened at the Sutherland observing station by the Prime Minister, Mr B J Vorster. As mentioned elsewhere, among the distinguished guests were Mrs Margaret Thatcher, at that time British Secretary of State for Education and Science, and nine world-renowned astronomers from various countries who also took part in an astrophysical symposium in Cape Town. In his opening address, the Prime Minister stressed the need for international co-operation in establishing sophisticated and costly research facilities such as those of the SAAO and expressed the hope that these facilities would be used by leading astronomers from all over the world in furthering knowledge of the southern skies.

Observing time for British and other astronomers

Under the CSIR-SERC* agreement, about 30 per cent of the observing time at Sutherland was made available each year to the United Kingdom. This enabled astronomers from the British universities, the Royal Greenwich

* SERC: Science and Engineering Research Council of Britain.

Observatory and the Royal Observatory, Edinburgh, to make astrophysical observations at the SAAO. Observing time was also assigned to astronomers from other countries for programmes of special importance. Some 70 to 80 astronomers from Britain and elsewhere came to work at Sutherland each year. Besides carrying out its own research programmes the SAAO placed its facilities at the disposal of astronomers in the South African universities.

When the initial stages of development were completed, the observatory was able to put into operation long-term research programmes. The four telescopes were equipped with a wide range of modern instrumentation, for example, a spectrograph with intensified reticon photon counting detector, CCD arrays, computer controlled photometers and a range of infrared systems including a bolometer, photometers, a three-channel scanning system and a low resolution spectrometer. The bulk of the data obtained could be stored on magnetic tape and image processing carried out by means of an advanced system on a VAX computer in Cape Town. Many of the programmes involved large amounts of observing and reduction time which would take a relatively long time to yield data in a form suitable for publication. This was nevertheless regarded as an important commitment of a national observatory such as the SAAO with a substantial number of long-term staff.

Sir Richard retired in 1976. In addition to the development of the Sutherland site and commissioning of the telescopes, he was responsible for a change in emphasis in the research work of the observatory from the mainly astrometric work to modern astrophysics. He was succeeded by Dr M W Feast, formerly of the Radcliffe Observatory, Pretoria, who had been appointed to the observatory staff in 1974.

Programmes and achievements of SAAO staff researchers included:

- Extensive studies of the stellar content, structure and distances of the two Magellanic clouds (the nearest galaxies which are of crucial importance in fixing the extragalactic distance scale). The small Magellanic cloud was found to be an extraordinarily elongated object in the line of sight (spindle-like and 60 000 light-years in length).
- Extensive studies of the stellar content, kinematics and distance of the central bulge of our galaxy. The accuracy of the measurement of the distance to the galactic centre was greatly improved (27 000 light-years with an uncertainty of 5 per cent).
- Studies of the physical nature of variable stars, including the discovery that cool giant variables (Mira stars) show a well defined relation between period and luminosity which is of great value in studying galactic and extragalactic distance scale problems.
- Much ground-based (optical and infrared) collaborative work with astronomical satellites observing in the X-ray, ultraviolet or infrared regions (for instance, the Einstein, EXOSAT, IUE and IRAS satellites). In the case of simultaneous ground-based and satellite work, the position of the SAAO in a longitude range not covered by other well-equipped southern observatories has often been of great importance. Among SAAO discov-

*Long-term research
programmes*



Dr M W Feast
Director, South African
Astronomical Observatory,
from 1976
(Chief Director from 1983)

eries in these fields was the remarkable nature of Cir X-1. This object was found from satellite observations to be varying in X-ray brightness, with flares recurring at intervals of about 16 days. The SAAO work showed that the infrared brightness of the object varies with the same period but in antiphase.

- Stellar evolution generally proceeds so slowly that it cannot be measured directly. However, studies of an unusual variable star with a period near 2,6 hours showed that the period is decreasing by 0,4 milliseconds a day and this was used to derive the direction and rate of its evolution.
- SAAO observations were extremely important in the initial discovery and subsequent study of the ring system around the planet Uranus.
- Observations provided convincing evidence for the existence of a companion (Charon) to the planet Pluto at a time when its existence was still being questioned.

GEOMAGNETISM

The Hermanus Magnetic Observatory, as this geophysical institution had come to be known to geophysicists throughout the world, was incorporated into the CSIR in April 1969. Founded in Cape Town in 1932 by Professor Alexander Ogg, head of the Department of Physics of the University of Cape Town, to undertake continuous observations of the earth's magnetic field for the International Polar Years, 1932–33, it continued to function under the auspices of the university until in 1938. In that year the Government, recognizing the national and international importance of this small institution, took over the observatory as a branch of the Trigonometrical Survey Office of the Department of Lands and moved it to Hermanus in January 1941. In 1968 the Cabinet, on the recommendation of the Scientific Advisory Council, decided that it should be transferred to the CSIR. When Professor Ogg retired in 1946 he was followed by Mr A M van Wijk as head of the observatory until his retirement in 1977 when he was succeeded by Dr G J Kühn.

The routine and research activities of the observatory made significant contributions to South African 'national scientific programmes' which were organized by the CSIR as part of South Africa's contribution to international scientific programmes, planned and co-ordinated under the auspices of the International Council of Scientific Unions (ICSU). These included the International Geophysical Year, 1957–58, the International Quiet Sun Years, 1964–65, and the International Magnetospheric Study, 1976–78.

Between 1960 and 1975, additional magnetic recording stations were established. The first was at the South African Antarctic base, Sanae, in 1960 (where the observatory also took on the responsibility for auroral observations). The second was some 14 km from Tsumeb in South West Africa/Namibia where the Max Planck Institut für Aeronomie (West Germany) established an ionosphere observation station in 1964 as part of its programme for the International Quiet Sun Years (IQSY) and also operated a magnetic recording station on behalf of the Magnetic Observatory. When the ionosphere observing programme of the Max Planck Institut was dis-

Magnetic Observatory, Hermanus



Mr A M van Wijk
Head, Magnetic Observatory,
1946 - 1977

continued in 1975, the station was taken over by the CSIR and run as a geophysical station by the Magnetic Observatory. In the meantime, a further station was established in 1972 at the Satellite Tracking and Remote Sensing Station of the CSIR's National Institute for Telecommunications Research at Hartebeesthoek near Johannesburg. A magnetic recording station at Grahamstown was operated by the Rhodes University Physics Department for the observatory from 1974 to 1979. Magnetic recording stations were also established on the Antarctic islands of Marion and Gough and operated in conjunction with special programmes.

The South African chain of stations form part of an international network. Data recorded at these stations are analysed at Hermanus and made available to the international scientific community in the form of data yearbooks. In addition to geomagnetism, other geophysical phenomena are also recorded. For example, recordings of aurora and magnetic pulsation phenomena are made at Sanae in Antarctica and those of cosmic rays (in association with the Physics Department of Potchefstroom University) at Hermanus and Tsumeb.

Through the foresight of Professor Ogg, who started a countrywide magnetic field survey programme in 1937, the Magnetic Observatory built up an invaluable data set of magnetic field measurements covering the whole subcontinent. For this purpose a network of some 60 primary magnetic field stations (repeat stations) has been maintained in South Africa and South West Africa. These surveys, which included Southern Rhodesia (Zimbabwe) from 1947 to 1975 and have included Botswana since 1975, were initially repeated at 10-year and later five-year intervals. In 1970, for example, field workers travelled more than 20 000 km from Hermanus in the south to Messina in the north and westwards to Cape Fria on the Skeleton Coast to complete a survey of all these stations.

The purpose of the five-yearly surveys is to provide charts and mathematical models of the magnetic field components for these regions and to determine the rate of the gradual long-term change of the main magnetic field (the so-called secular variation). Charts and models are derived after the survey data have been corrected for short-period temporal variations, determined from data obtained at the continuous recording stations.

Changes in the geomagnetic secular variation pattern in southern Africa and the surrounding oceans are of particular interest to geophysicists. Since the first measurements were made in 1843, the value of the horizontal intensity at Cape Town has decreased by half (H 22000nT in 1843; H 11000nT in 1985) and there are no indications that the rate of decrease is diminishing. The relatively low intensity as well as the continued decrease are of interest not only for the study of the influence of the geomagnetic field on aeronomic processes but also for the study of the geomagnetic field and its secular variation.

Although the production of charts giving information on long-term changes in the earth's magnetic field is one of the main routine functions of the observatory, it is the temporal and transient magnetic variations that are the focus of its research programmes. These transient variations which are superimposed on the steady background geomagnetic field are a regular



Dr G J Kühn, Head, Magnetic Observatory, from 1977

*Magnetic field
surveys*

*Transient magnetic
observations*

Mapping crustal magnetic anomalies

diurnal variation related to the positions of the sun and the moon and sporadic irregular variations caused by charged particles emitted by the sun, known as magnetic disturbances or substorms.

Since 1975 research at the Magnetic Observatory has been focused mainly on –

- transient magnetic variations such as substorms and magnetic pulsations occurring in the magnetosphere surrounding the earth;
- the use of geomagnetic data obtained by satellites to map magnetic anomalies in the earth's crust; and
- the development of expertise in the geophysical exploration method known as 'magnetotelluric sounding'.

In 1979 NASA launched a satellite known as MAGSAT for the sole purpose of recording the geomagnetic field and its components at altitudes varying between 250 and 500 km above the earth. Although the satellite remained in orbit only until June 1980, it accumulated a wealth of information on the geomagnetic field. Data tapes from MAGSAT were made available to the Magnetic Observatory in exchange for data from its special field survey to provide 'ground truth' for MAGSAT (i.e. surface data for correlating the satellite data). This enabled the observatory to undertake mapping of crustal magnetic anomalies in the southern Africa region – a development of great interest to geologists and geophysicists in South Africa.

Chemistry, Natural Products and Related Technologies

CHEMISTRY

At its first meeting in October 1945, the newly appointed Council of the CSIR decided that, in addition to a National Physical Laboratory, a National Chemical Research Laboratory should be established. This intention was clearly stated in the publication *Objects and Policy of the CSIR – an initial statement* issued in December 1945 (see p. 25). The inclusion of the word 'research' in the title is of some significance as indicating the Council's view that the main focus of the laboratory should be on long-term research. There were some doubts about the way in which this laboratory should be organized, and early in 1946 Schonland invited the views of a number of leading chemical research workers. One of them was Dr W S Rapson, senior lecturer in chemistry at the University of Cape Town, to whom the post of Director was offered in May 1946. He took up the appointment in January 1947.

In Dr Rapson's own words: 'Scientifically oriented chemical research had not developed to any significant extent in South African universities prior to World War II, and after the war there was still very little such research in

progress. . . . Under these circumstances and when research-trained personnel and modern equipment were so difficult to come by, it was felt that national research laboratories such as the National Chemical Research Laboratory should contribute to alleviating the shortage of manpower for research by the training of research personnel in contexts where specialized and up-to-date equipment was available. One background objective of the laboratory in its early days was therefore to initiate research projects and establish facilities within which such training could be effected. One of its accepted functions was that of building up a national reservoir of specialized chemical talents and skills.

'This essentially academic objective was, however, only a means to an end. The overriding objective was not the advancement of chemical knowledge *per se* but the application of chemistry and chemical research in the development of industry in South Africa.

'In this connection, it might at first sight be thought that a National Chemical Research Laboratory should have as its main and natural objective the development of chemical industry. However, of all industries in South Africa and elsewhere in the world at that time, the chemical industry was perhaps the one which was scientifically the most self-sufficient. There were therefore few opportunities for constructive research in this area and little justification for its conduct by a statutory agency.

'A far more promising and fruitful area of operation was seen in the application of chemistry and chemical technology to the exploitation of national resources such as those of mining, agriculture, fishing, forestry and animal husbandry, and to the conservation and efficient use of the most basic of all material resources, namely water.

'That institutional research could contribute materially in this area had already been demonstrated by the Department of Agriculture in its various institutes and especially in the Veterinary Research Institute at Onderstepoort. It had also been demonstrated in our universities in a variety of contexts, in which such research had been initiated and had flourished with support not only from the universities themselves but also from government departments or agencies, primary producers and processing industries.'

Some examples of research at universities supported by industry were leather research at Rhodes University under Dr S G Shuttleworth, marine oils at the University of Cape Town under Dr W S Rapson, and minerals processing and beneficiation at the University of the Witwatersrand under Professor G H Stanley.

According to Dr Rapson, 'support and initiation of activities of these types clearly offered to the CSIR an excellent means of involving in research and development a variety of industries in South Africa which were still operating along traditional lines without serious consideration of the potential benefits which might accrue to them as a result of the developments in the application of science to technological processes.' These were among the main considerations which Dr Rapson had in mind when he started planning the National Chemical Research Laboratory.

Although he was only to take up his appointment as director at the beginning of 1947, he spent the university vacation of July 1946 at the CSIR in Visagie Street, Pretoria. At that time there was an extreme shortage of scientific equipment and delivery times from overseas were rarely less than six months and all too often between one and two years. He spent the month in 'a bare, bleak and freezing south-facing room' placing orders for basic technical equipment and supplies.

During the next six months at the University of Cape Town he made some preliminary appointments drawing from his own past students and colleagues. Notable among these was Dr P C Carman, senior lecturer at the University of Cape town, to take charge of physical chemistry. They were to form a fruitful partnership in those early days of the of the NCRL. Other early appointments were Dr Helen Schwartz, who continued to work on fish liver oils and related substances for some years at the UCT in a CSIR Oil, Fats and Waxes Unit, and Dr J R Nunn, who also continued to work at the UCT in a CSIR Seaweed and Carbohydrate Research Unit.

Biochemical Nutrition Research

Another arrangement of a slightly different kind was the establishment in 1946 of a CSIR Biochemical Nutrition Research Unit at the South African Institute for Medical Research in Johannesburg under Dr A R P Walker. This later became one of the units supported by the CSIR's Committee for Research in the Medical Sciences.

When Rapson arrived in Pretoria, the conversion of part of the buildings of the former munitions section of the South African Mint into chemical laboratories had only just begun. As little could be done on the spot and so much could be learnt from the experience of others overseas, he and Dr Carman, who had assumed duty in April, went on a six-months' overseas study tour.

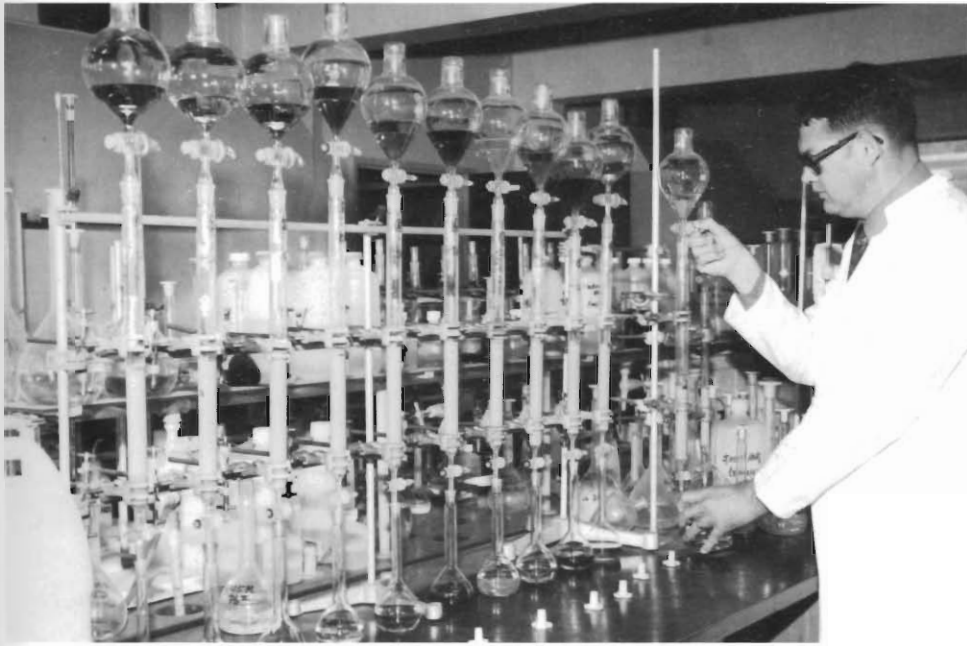
When they returned the laboratories were almost ready and the search for suitably qualified staff for the divisions which were envisaged began in earnest. Dr D A Sutton of the Paint Research Station at Teddington, England, whom Dr Rapson had interviewed while in Britain, took up an appointment as head of the Organic Chemistry Division in 1949, thereby relieving Dr Rapson of direct responsibility for this activity. Dr O B Volckman of the British Distillers' Corporation, England, arrived in 1948 to take charge of the Process Development Division, which was initially supervised by Carman. As Carman considered macromolecular chemistry to be an important field for which no facilities or expertise existed, Dr F J Joubert was sent overseas for training and later became head of a Division for Macromolecular Chemistry.

Corrosion Research

When Dr J N Wanklyn, who had been sent overseas in 1946 for specialized training in corrosion research, left to take up an appointment overseas, Commander W J Copenhagen, who had retired from the Division of Chemical Services of the Department of Agriculture, was temporarily put in charge of corrosion services. Increasing recognition of the importance of this work came later with the formation of the CSIR Corrosion Group in 1962 under Dr C E Bird.

Water Research

A significant early development was the establishment of a Water Research Unit under Dr H M Wilson, retired chief city biochemist of Johannesburg.



Ion exchange separation columns
in the National Chemical Research
Laboratory.

With the appointment of Mr (later Dr) G J Stander, former city biochemist of East London, as his right hand man, research began on projects such as the purification of effluents from fermentation industries by anaerobic (methane) fermentation processes and on the efficiency of sand filters, in the final purification of sewage effluents. At first the unit was housed in a prefabricated hut at the University of the Witwatersrand, but by 1952 had become integrated as a fully fledged division of the NCRL under Dr G J Stander. The activities continued to expand rapidly until in 1958 it was hived off as a separate institute.

The original intention to set up a Microbiological Division in 1946 was not realized because of the early resignations of first Dr A E Oxford of the London School of Hygiene and Tropical Medicine and then of Dr C P J Spruit of Holland, who had in turn been appointed to head the Division. At this stage Rapson decided to bring Dr Schwartz from Cape Town to head a Biochemical Division incorporating the microbiological work for which Dr J P van der Walt, who had studied in Holland, was appointed in 1952. Later Dr van der Walt became head of a separate CSIR Microbiological Research Group in which the activities in this field of the NCRL and the National Nutrition Research Institute were combined.

In 1954 certain municipalities approached the CSIR with problems they were having in the large-scale brewing of sorghum beer. The project was assigned to Dr Schwartz's Biochemistry Division with Dr L Novellie as project leader. In recognition of the NCRL's early contributions towards improved brewing methods, the responsible government department later introduced a levy to place the funding of this research on a sound footing, and Novellie became head of a Sorghum Beer Unit, with a separate budget, in 1962.

Microbiology

Sorghum beer

Nutrition Research

In 1952 a new Department of Nutrition was created by the Government with a section for research. In June of the following year, however, it was decided that this section should be replaced by a Nutrition Research Unit in the National Chemical Research Laboratory of the CSIR to undertake research on behalf of the Department of Nutrition. It was never intended that this unit should be an integral part of the NCRL. However, under Rapson's leadership it was developed on sound scientific lines and in 1954 became a National Nutrition Research Institute of the CSIR with Dr A W Lategan, a former PhD student of Dr Rapson, as first director.

Although the initial policy was to develop research programmes and projects based on the use of raw materials, it soon became evident that the more technologically oriented research institutes which had been established (such as the National Building Research Institute, the National Nutrition Research Institute and the co-operative industrial research institutes), were providing a framework for the investigation of the technological problems of industry. Although the institutes opened the way for the introduction of new science and technology on a broad front to the industries they served, the discipline involved in almost all cases was that of chemistry. In contrast, the facilities which these technological research institutes could offer for more fundamental chemical research in their respective fields were relatively limited. Accordingly, from 1955 onwards, an increasing number of research projects were selected, in consultation with these other institutes, aimed at providing reinforcement on the fundamental side for the study of the more practical problems with which they were concerned.

Similar considerations applied to collaboration with government departments which were engaged in research and development. In particular, the Departments of Agriculture, Mines, Irrigation (Water Affairs), Health and Nutrition were all engaged during this period in reviewing their needs in respect of scientific and technical research services and the manner in which they might best be met in the future. Naturally, the question of whether and to what extent they might use the resources of the CSIR was crucial, and for some time, there was a reluctance to use the CSIR for fear that this might prove prejudicial to acceptance of their own development plans. This, however, was a passing phase. With the establishment of the Prime Minister's Scientific Advisory Council in 1962, a formal framework was created through which such issues could be reviewed and resolved in accordance with an overall State policy.

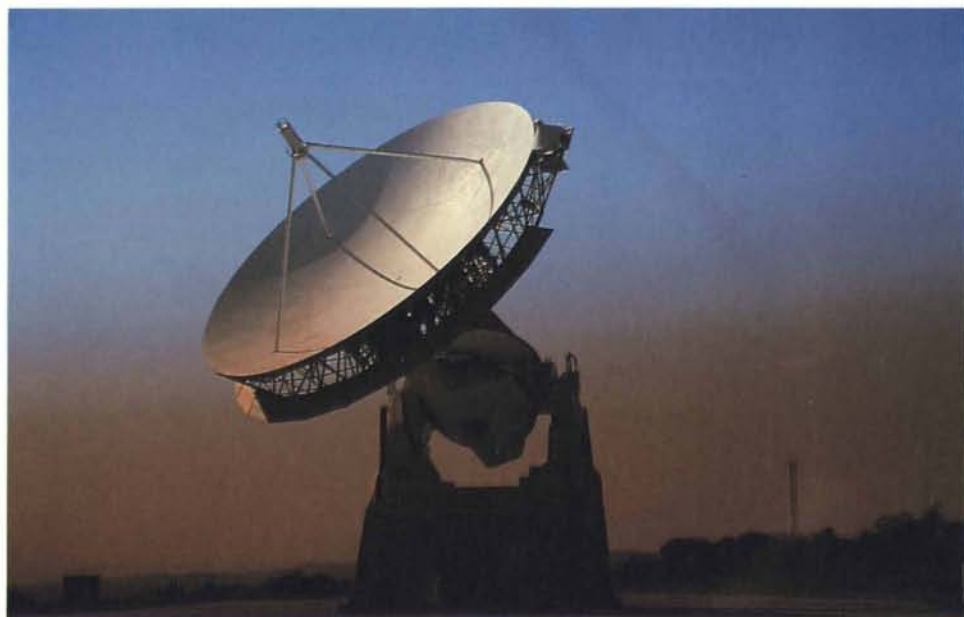
Rumen digestion research

Against this background, a number of collaborative projects were undertaken with the Department of Agricultural Technical Services. Most of the chemical research was done in the CSIR laboratories while the animal and plant research was carried out at Onderstepoort and other laboratories of the department. There was, however, a free interchange of staff between the CSIR and the agricultural laboratories. A good example is afforded by the co-operation between the NCRL and the Veterinary Research Institute at Onderstepoort in research on the digestion of ruminant animals. When Dr Frances Gilchrist was appointed to a research fellowship on rumen digestion at Onderstepoort, she worked for a time in the Biochemistry Division of the NCRL with Dr Helen Schwartz until adequate facilities were made



A harbour design is tested in the hydraulics hall of the National Research Institute for Oceanology in Stellenbosch.

One of the specialised satellite tracking antennae at the Satellite Remote Sensing Centre at Hartebeesthoek near Krugersdorp.



A systematically corrected, edge-enhanced Landsat satellite image of the Pretoria/Johannesburg area.



available at Onderstepoort. Gradually a strong Rumen Digestion Unit was built up and its highly successful and important work gained international recognition, and members of its staff were regularly invited to deliver papers at international conferences and to serve on international committees in this field.

Collaboration with industry was facilitated by CSIR schemes under which individual firms or groups of firms could support long-term programmes through industrial fellowships or short-term *ad hoc* research and development contract projects in the CSIR laboratories. It became possible, within limits, to agree with each particular sponsor on contract conditions appropriate both to the sponsor's circumstances and the task on hand. The flexibility of these arrangements was a significant advance when compared with the policies of state organizations with responsibilities similar to those of the CSIR in other countries at the time.

The National Chemical Research Laboratory could therefore expand the scope of its operations considerably beyond that which would have been possible in terms of its own budget. This applied particularly to research relating to such fields as wool and its by-products, marine oils, water supplies and the treatment of sewage and industrial effluents, corrosion, nutrition and food processing, pulp and paper production and ceramic raw materials.

To identify the needs and opportunities for co-operative research of this nature, the director was assisted by staff of the Industrial Liaison Division, who were attached to the NCRL. Among these were Mr G G Cillié (later director of the National Institute for Water Research), Mr A M Schady (later manager of the South African Inventions Development Corporation), Mr T F W Harris (later professor of oceanology at the University of Cape Town) and Dr R G Shuttleworth and Mr C G Hide, who later on became heads of the CSIR's overseas liaison offices in London and Washington. In addition to dealing with enquiries for technical information and advice, they helped to negotiate contracts with industrial and other sponsors.

Industrial Liaison

As the scope of the laboratory's activities extended to areas of the country far from Pretoria, the need for regional liaison activities increased and with it the need for regional research facilities. In South West Africa, Natal and the Cape these facilities were initially established largely as a result of the requirements of the Water Research Division of the laboratory in connection with water supply and effluent treatment.

Although the developments which have been described by no means cover all the activities in which the NCRL became involved, they do illustrate that by the end of the 1950s the laboratory had become a mature research organization.

At this stage the activities of the NCRL included the following:

- *Mineral products*, including clays (supported in part by a fellowship sponsored by the Superwhite Kaolin Corporation), phosphates (sponsored by Foskor), and oil from coal catalysts (sponsored by Sasol). (The possibility of the CSIR's involvement through the NCRL and its Chemical Engineering Research Group in the beneficiation and processing of

South Africa's mineral resources was considered. However, after thorough investigation and careful deliberation the Council decided that no initiative should be taken in this connection.)

- *Plant and animal products*, including wool wax and wool fibres (sponsored by the Wool Board), essential oils (in collaboration with the Division of Horticulture of the Department of Agriculture), a survey of South African plants for alkaloids (sponsored by Smith, Kline and French of Philadelphia, USA), poisonous plants (in collaboration with the Veterinary Research Institute at Onderstepoort), bitter principle of Cucurbitaceae, the hemicelluloses of wattle wood (sponsored by the Wattle Growers' Association), pulping qualities of South African timbers (sponsored by Sappi), sorghum and sorghum beer (sponsored by the Institute of Administration of Non-European Affairs).
- *Medical biochemistry*, including the chemical mechanism of carcinogenesis (supported by the National Cancer Association and carried out in collaboration with the CSIR Nutrition Research Unit at the University of the Witwatersrand).
- *Microbiological chemistry*, including wine research (carried out by a Wine Industry Research Unit at the Western Province Fruit Research Institute of the Department of Agriculture at Stellenbosch) and metabolism in ruminants (in collaboration with the Veterinary Research Laboratories at Onderstepoort).
- *Process development*, the major effort directed at the design, erection and commissioning of a 2,5 million gallon a day plant at the Free State Geduld Mine at Welkom for the demineralization of mine water by the process of electro dialysis, and related research and development on improved permselective membranes.
- *Physical and analytical chemistry*, including radiochemistry (in collaboration with the Nuclear Physics and Radioactivity Divisions of the National Physical Research Laboratory and other laboratories), corrosion investigations (mainly in connection with problems arising in industry and in the provision of assistance to government departments), studies of ion exchange in analysis and routine analytical services.

Several significant organizational changes were made later. The Water Research Division was hived off to form a National Institute for Water Research. In the planning of laboratory accommodation on the new CSIR site, provision was made for separate buildings for this institute as well as for the National Nutrition Research Institute and the Process Development Division, which was to become a CSIR Chemical Engineering Research Group. The research of the NCRL in ceramics, timber and corrosion was combined with the work of other CSIR institutes, in particular the National Building Research Institute, to form a Ceramics Research Unit, a Timber Research Unit and a Corrosion Research Group.

The main laboratory building was completed and the NCRL moved to the new CSIR site, Scientia, in 1959. From then onwards the emphasis in the laboratory's activities was to change. Until then the concentration of most of its resources on industrial raw materials and the technologies involved in



The National Chemical Research Laboratory building on the CSIR site Scientia, completed in 1959.

processing them had made it a CSIR instrument for technological as much as scientific research in the field of chemistry. During the 1960s this was to change and the laboratory was to flourish as a national centre of excellence in chemical research to which industry and other organizations could turn when they had problems which required specialist skills and equipment.

When it became evident that the research activities of the laboratory were being hampered by a lack of specialized equipment, especially spectroscopic instrumentation, a Chemical Physics Group was formed to share the use of new expensive instrumentation and to develop the necessary expertise to ensure the effective use of such equipment. The first group head was Dr F H Herbstein of the NPRL. The NCRL was mainly responsible for infrared spectroscopy and nuclear magnetic resonance spectroscopy under the direction of Dr C J H Schutte and Dr K G R Pachler respectively, while X-ray crystallography, high-pressure physics and electron spin resonance spectroscopy were developed by the NPRL. From the outset nuclear magnetic resonance spectroscopy and X-ray crystallographic data collection were made available to universities and other research institutions. To these services were added a high-resolution mass spectrometer installed at the NCRL in 1965 and shortly afterwards an instrument for the recording of optical rotatory dispersion and circular dichroism spectra. From then on chemists in the country had access to the more important spectroscopic instrumentation needed for carrying out chemical research.

From the 1960s onwards fundamental research at the NCRL concentrated on fields in which there was a demand for more knowledge to solve practical problems. In later years the basic pattern did not change much, although

*Chemical Physics
Research Group*

there were shifts in emphasis. The wide and varied scope of this research is reflected in the following selected examples:

- In addition to the use of nuclear magnetic resonance spectroscopy for the structure elucidation of chemical compounds isolated by the NCRL, universities and other research institutions, fundamental developments and new applications of nuclear magnetic resonance spectroscopy were carried out by the NCRL.
- The synthesis of rare carbohydrates suited for conversion into medically useful nucleosides and antibiotics received increasing attention. Research at the NCRL concentrated on the development and application of synthetic methods for the preparation of novel carbohydrates. Notable examples included the preparation of cyanosugars and the reduction of halogenosugars to unsaturated compounds; intermediates of these types were shown to be extremely versatile in the preparation of a variety of pharmacologically important substances.
- Steroid hormone research focused on the synthesis and conformational properties of a series of modified pregnane analogues. It was demonstrated through force field studies and X-ray crystallography that specific arrays of functional groups were responsible for skeletal deformation in certain retrosteroids. This information was used to advantage in defining new synthetic objectives.

A new method was developed for the degradation of bile acids to pregnane derivatives suitable for use as intermediates in the preparation of medically useful steroidal hormones. The method was claimed to be less involved than existing methods, with comparable overall yields.

- Great success was achieved by the NCRL in developing a new method for the cheaper preparation of human growth hormone from human pituitaries. Not only did it give a higher yield, with a purity of 95 per cent instead of the 45 per cent of the commercially available product, but the activity of this South African product was also double that of the product available from overseas. The snag was that the legal position in South Africa was such that the preparation of human growth hormone was virtually impossible. These difficulties were overcome with the cooperation of the Medical Research Council, the medical schools of the Universities of Natal and Cape Town, and the Faculty of Law of the University of South Africa. An amendment to the Anatomical Donations and Post Mortem Examinations Act passed in 1973 enabled scientists to obtain enough human pituitary glands to produce human growth hormone for the treatment of all pituitary dwarfs in South Africa.
- Protein studies in which the NCRL established world leadership in research on the amino-acid sequences of snake venom proteins, leading to collaboration in this field with several other institutes and organizations.

Research revealed that the venom of a South African adder, *Bitis caudalis*, was an extremely potent neurotoxin, on a par with that of the cobra and mamba. It was found that the commercially available snakebite antiserums offered no protection against this toxin. The South African Institute for Medical Research was alerted.



Venom is extracted from a puff adder for analysis in the NCRL.

- Following a request from the Egg Control Board, the NCRL developed a process for the extraction of lysozyme from egg albumen. When sold as a separate commodity, this wide-spectrum bacteriolytic agent, which is used in the pharmaceutical, brewing, cosmetic and food processing industries, could offset the losses incurred by marketing the whole powdered albumen overseas. The process developed by the NCRL gave a lysozyme recovery of over 90 per cent, free of all contaminants and biologically active; an important advantage of the process was that the usefulness of the remaining albumen for other industries, such as baking and confectionery, was retained.
- Structural and biosynthetic studies on mycotoxins undertaken in collaboration with the Medical Research Council concentrated on problems relating to fungal contamination of human and animal foodstuffs.
- A feature of research in the field of analytical chemistry was a systematic study of ion exchange techniques, which showed that much improvement in time and accuracy could be achieved in the analysis of solutions containing small amounts of many elements. In 1971, the leader of this work, who was a member of the CSIR team which analysed moon samples, regularly analysed samples used for international reference. It was claimed that, at that stage, his was the only complete ion-exchange system used to analyse lunar material and that it was believed to give more accurate results than classical silicate rock analysis or the newer instrument methods.

This, it was claimed, was borne out by analyses of two lunar samples for which 12 elements had to be determined in 0,25 g of material. The long-term aim of the systematic determination of ion-exchange distribution

Three consecutive directors of the National Chemical Research Laboratory. They are (centre) Dr W S Rapson (1946-1958); (right) Dr P C Carman (1958-1972); and Dr P R Enslin (1972-1983).



coefficients was to collect fundamental data for use in developing methods for the complete separation of complex mixtures of inorganic elements. The data collected proved to be valuable not only for analytical chemists but also found application in other fields, such as radiochemistry, throughout the world.

- Fundamental research on the platinum group of metals attracted considerable interest and in 1976 financial support by the platinum producers, through the Chamber of Mines, was reviewed and increased a second five-year period. A detailed understanding of the reaction mechanisms is a prerequisite for the successful application of metal complexes as catalysts in the conversion of organic molecules in industrial synthesis processes.

Attention was focused on ruthenium, one of the six platinum-group metals with limited industrial use - in contrast to rhodium, another metal of the group, which is rarer but widely used as a catalyst in industrial chemical processes. As it was estimated that the demand for rhodium would exceed supply towards the end of the century, all the expertise and relevant facilities of the NCRL were directed towards the preparation of ruthenium complexes as possible replacements for rhodium catalysts. As success in this direction held the promise of large exports of ruthenium complexes, the NCRL was encouraged by the willingness of an overseas company to test the complexes which had been prepared.

- Among the earlier achievements of the team working on ruminant digestion in collaboration with the Department of Agricultural Technical Services at Onderstepoort was the finding that the microbial population in the rumen of sheep changed with diet. Further research showed that when grain supplements were fed to ruminants, both the intake and digestion of roughage were lowered. This could happen even when there was no shortage of nitrogen for the rumen bacteria, and when there was no increase in the acidity of the rumen contents – factors which were previously thought to be responsible for the lowered use of the fibrous part of the diet. From this it was deduced that the presence of starch, or the sugars formed from it, might inhibit the synthesis or activity of the bacterial enzymes which broke down cellulose and hemicellulose in the



Dr J R Bull
Chief Director, National Chemical Research Laboratory, from 1983

rumen. This finding had practical implications in the formulation of a strategy for supplementing ruminant diets.

These examples illustrate some of the ways in which the NCRL fulfilled its mission in providing a focal point for the discipline of chemistry. Not only was it a seed-bed from which many other research activities grew, but also a training ground for young research workers, many of whom moved on to senior positions in other research organizations, universities and industry.

The ideals and standards of excellence were maintained throughout by succeeding directors. When in 1958 Dr Rapson was appointed vice-president of the CSIR he was succeeded as director by Dr P C Carman. On his retirement in 1972, Dr P R Enslin, head of the Organic Chemistry Division, became director. He was followed as director by another head of the Organic Chemistry Division, Dr J R Bull, in 1983.

CHEMICAL ENGINEERING

The activities of the Process Development Division of the NCRL under Dr O Volckman were extended with the formation of a Chemical Engineering Group, first under Mr C G Bruckmann, and from 1969 under Mr W G B Mandersloot. However, it continued to be supervised by the NCRL until 1973 when it became a separate entity, the Chemical Engineering Research Group (CERG) within the CSIR (head: W G B Mandersloot).

Because of the interdisciplinary nature of its activities and the wide application of process technology, the group maintained close contact with other sectors of the CSIR and with outside organizations.

In its services to industry the group used the expertise developed either in-house or through its membership of international research groups. The research activities were directed towards those key technologies in the process industry that were of specific importance in South Africa.

Over the years the group developed a series of services which were widely used by companies or individuals on a contract basis. These included advice and information required in solving processing and related problems. The following are some examples:

- *Process technology* – long-term and short-term investigations with the use of the group's semitechnical-scale equipment for drying and the development of dryers for difficult conditions, mixing, extracting, etc. In the early 1980s it was estimated that the annual expenditure on energy for drying in South Africa exceeded R300 million, which made drying the major consumer of energy in the local process industry.
- *Particle characterization* – an essential prerequisite for research on solid/liquid separation, which is of particular interest to the minerals processing industry. The group's range of particle characterization equipment included an X-ray sedimentometer and an automatic BET absorption instrument for the determination of particle surface area. Materials characterized included aluminas, carbon, cement, coffee, coffee cream, diamonds, fly ash, lime, mica, pharmaceuticals, pyrite, ruthenium, silicas, sulphur and unknown impurities in liquids.

Chemical Engineering Research Group



Mr W G B Mandersloot
Head, Chemical Engineering
Research Group, from 1973

- *Evaluation of manganese dioxide* – the evaluation of manganese dioxide ore samples for use in the manufacture of small batteries (dry cells) using the pulse galvanostatic analyser developed by the group and also supplied to overseas battery manufacturers. At the request of an overseas user, an updated version of this instrument incorporating modern integrated circuitry and technology was developed in the 1980s.
- *Heat transfer* – air-cooled and plate heat exchangers; computer-aided design of heat exchangers and dryers including performance evaluation, making use of computer programs either developed by the group or obtained from elsewhere, e.g. from the heat transfer and fluid flow service of the Atomic Energy Research Establishment at Harwell in England, with which close co-operation was established. This work also included calibration of flowmeters and manifold design.
- *Control of air pollution* – sampling of industrial emissions, provision of tailor-made sampling equipment for special purposes and advice on the control of emissions (the measurement of emissions was mostly concerned with the dust load of emissions and usually a particle size analysis as well and, in certain cases, testing the emissions for gases).

Research activities other than those related to these services were aimed at a better understanding of processes involved in practical operations, such as:

- Electrodialysis – particularly in the demineralization of water.
- The more efficient use of rotary filters, which are widely used in South African industry, especially in the processing of gold and uranium ore, for reclaiming solids from slurry and for purifying liquids by removing solids.
- Preparation and evaluation of catalysts such as zeolites (crystalline porous alumina silicates), which are widely used in the conversion of synthesis gas (from coal or natural gas) to liquid fuels and petrochemicals, imports of which run into several million rands annually.

In the 1980s the facilities and know-how for the preparation and evaluation of catalysts, particularly those related to synthetic fuels processing, were built up. Of particular interest was the development of catalysts for alternative routes (non-Fischer-Tropsch) to synthetic liquid fuels, as well as for reducing the quantity of by-products formed in traditional Fischer-Tropsch synthesis.

- A development parallel to the important field of liquid fuel production concerned reactor technology and the group worked on methods whereby more efficient and more selective conversions of synthetic gas would be attained. The slurry reactor was identified as having the greatest potential for enhanced production compared with the traditional synthesis reactors. A pilot-scale reactor system for providing design parameters was constructed and used to generate design information. This work was carried out with the close involvement of industry.

In the late 1970s and early 1980s the CERG focused attention on developing processes for the local production of chemicals other than large-scale



The Chemical Engineering Research Group's building adjacent to that of the National Chemical Research Laboratory.

chemical commodities. A Committee for Chemical Projects was formed with members from within the CSIR (CERG, National Chemical Research Laboratory, Group for Techno-Economic Studies and the Foundation for Research Development), from Mintek, the Industrial Development Corporation and private enterprise. The objective of the committee was to identify chemicals that were currently being imported but for which the resources for local and economical production were available. Although the emphasis was on import replacement, export potential was also evaluated.

FOOD AND NUTRITION

In the years following the Second World War there was widespread interest in all aspects of human nutrition. Possibly this concern was one of the early indications of the awakening of the conscience of the First World, prompted by increasing awareness of the plight of the peoples of Third World countries (most of which, at that time, were colonial territories). In South Africa this interest was reflected, amongst others, in the emergence of research groups mainly at the universities. By 1954, five of these groups were being supported by the CSIR through its scheme for medical research units under the auspices of its Committee for Research in the Medical Sciences.

These research groups were: Nutrition Research Unit under Professor J Gillman, University of the Witwatersrand, the Clinical Nutrition Unit under Professor J F Brock, University of Cape Town, the Human Biochemistry Research Unit under Dr A R P Walker, South African Institute for Medical Research, Johannesburg, the Prison Research Group on Diet and Metabolism relating to Cardio-Vascular Diseases under Dr P J Kloppers, University of Pretoria, and the Nutrition and Dental Health Research Group under Professor C L de Jager, University of Pretoria.

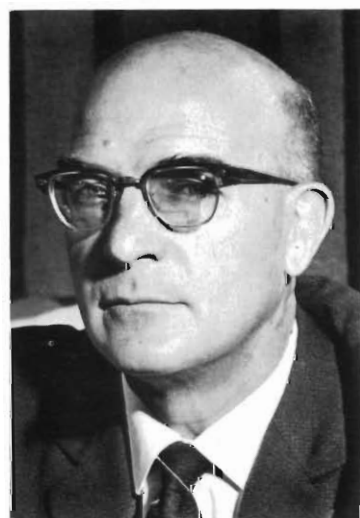
In 1952 the Government established a Department of Nutrition with a section for research. The following year, however, it was decided that this section should be replaced by a Nutrition Research Unit in the National

*National Nutrition
Research Unit*



Dr A W Lategan
Director, National Nutrition
Research Institute, 1954-1957

Food enrichment



Dr F W Quass
Director, National Nutrition
Research Institute, 1957-1965

Chemical Research Laboratory of the CSIR, to which some members of the department's research staff were transferred. Members of the original steering committee of this unit were Dr P J du Toit (CSIR) as chairman, Professor S F Oosthuizen (CSIR Committee for Research in the Medical Sciences), Dr S M Naudé (president, CSIR), Professor D G Haylett (Department of Agriculture), Mr C H Spamer (Department of Nutrition), and Dr J M Latsky (National Nutrition Council).

The unit was at first housed in a building known as Impala House in Schoeman Street, Pretoria. With the co-operation of the Agriculture Research Institute of the University of Pretoria and the Veterinary Research Institute at Onderstepoort a start was made with the biological evaluation of foodstuffs, while relevant chemical and food technology research was undertaken in the NCRL. Following rapid expansion, the unit became a fully fledged National Research Institute of the CSIR on 1 October 1954 with Dr A W Lategan as director. Its research was organized in the following sections: food chemistry, food technology, physiology, physiological chemistry, histopathology and clinical investigation. When in 1957 Dr A W Lategan was appointed director of the South African Bureau of Standards, he was succeeded by Dr F W Quass.

As the Department of Nutrition had a specific interest in the enrichment of bread with fish flour and groundnuts, much of the early work of the National Nutrition Research Institute (NNRI) was concerned with the implementation and evaluation of this scheme in collaboration with the Fishing Industry Research Institute in Cape Town. These investigations were extended to cover all aspects of the principles of State-supported enrichment of food on a national scale. After three years the results were embodied in a preliminary report and published in 1960 under the title *A Study of Principles of Food Enrichment and their Application to Food Policy in South Africa (with special reference to the use of fish flour for the protein enrichment of bread)*. This included a study of the general principles of food enrichment, a lengthy review of available information on the nutritional status of the different sections of the South African population and a study of the biological evaluation of foodstuffs, with special reference to fish flour. It was concluded that the bread enrichment schemes of the Government failed to meet many of the basic requirements of an effective enrichment policy, particularly those of proteins, and that there was therefore no scientific justification for such a scheme. Two of the criteria established by the institute were that the amounts of enriching substances provided should be sufficient to satisfy the proven need, and that the enrichment medium should be regularly consumed in significant quantities by those whose diets were deficient in specific nutrients.

As may be imagined this report caused great consternation in the Department of Nutrition which challenged the findings of the institute. Accordingly, the Government appointed a committee of enquiry under Dr H O Mönning, scientific adviser to the Prime Minister. The report of this Committee fully vindicated the findings of the institute and recommended the discontinuation of the Department's bread enrichment scheme. The recommendation was accepted by the Government which dismantled the Department of Nutrition and allocated its remaining functions to the Departments



The National Food Research Institute's building shortly after completion in 1959.

of Agriculture and of Health. This somewhat drastic reaction came as a shock to the Public Service and for some years afterwards led to strained relations between the CSIR and some elements in the government departments.

In the meantime the Department of Nutrition had allocated £150 000 towards a building for the institute on the CSIR's new site, Scientia.

The building was occupied in 1959. By that time the institute comprised divisions for food chemistry, food technology, cereal chemistry, protein chemistry, food microbiology, biological evaluation, physiological chemistry, physiology and field surveys, and a child nutrition clinic.

The major work of the National Nutrition Research Institute on food and nutrition was aimed at determining the nature and extent of malnutrition, both undernutrition and overnutrition, and at finding out how best to combat unfavourable conditions.

In planning a survey of the nutritional status of the South African population, methods and criteria suited to this country, with its heterogeneous population had to be developed. The two main categories of diseases were those caused by malnutrition and by undernutrition such as kwashiorkor, marasmus, pellagra, angular stomatitis, siderosis, fatty infiltration of the liver and certain trace element deficiencies, and those believed to be caused by overnutrition, such as the cardiovascular diseases. A survey of Pretoria schoolchildren of all races was carried out and wards for the study of nutritional diseases in both children and adults were provided at the H F Verwoerd Hospital in Pretoria. The publications of Dr P G Pretorius, head of the NNRI's children's clinic, attracted much international attention. On the basis of the findings of these surveys, the milling industry was persuaded to market maize meal fortified with nicotinic acid and riboflavin largely owing to the efforts of Dr P van Twisk and Dr J du Plessis.

Undernutrition

Research into the sterilization of canned foods at the NERI.



Certain diseases of particular concern to South Africa and other African States were investigated. In South Africa, kwashiorkor*, marasmus and pellagra were by far the most dramatic of the diseases caused by malnutrition and undernutrition. Special attention was therefore paid to the pathology of these diseases and to the investigation of cheap, high-protein foods such as skim milk powder as an additive to the staple cereal diet in combating them. Once the value of skim milk powder had been established, work continued on the preparation and testing of combinations of skim milk powder with other high protein foods (such as fish, soya flour and egg powder), and vegetable and mineral products likely to ensure the provision of sufficient protective nutrients at lower cost, particularly to children in the age group of six months to five years. This work culminated in the development of the so-called PVM mixture (P:protein; V:vitamin; M:mineral).

Largely as a result of the efforts of the institute, kwashiorkor was declared a notifiable disease in 1962 (until then only infectious and contagious diseases were notifiable by law).

Overnutrition

As overnutrition was considered to be one of the contributory causes of degenerative cardiovascular diseases, research in this field was included in the programme of the institute. Although these diseases are not peculiar to South Africa, the pattern of their incidence in the different population groups (low among blacks and high among whites) in this country offered exceptional opportunities for comparative studies. The aim of the National Nutrition Research Institute was to obtain basic information which would assist the medical profession in determining at an early stage whether an individual was likely to develop cardiovascular diseases later, and whether the unfavourable metabolic pattern of susceptible people could be corrected by a change of dietary habits. As a supplement to this work experimental

* According to Dr F W Quass, 'kwashiorkor' is derived from the language of Ghana and means 'one-two' or 'first-second'. It is customary among the black peoples of Africa for the mother to breastfeed her baby for as long as possible to avoid another pregnancy. Should a second baby arrive the mother has to suckle it and the first baby has to be fed on a diet of grain and starch foods. This results in kwashiorkor. Current views on the matter include the possible involvement of a toxic agent as a contributing factor.

animals were used, and in 1968 a primate centre was established for this research. A major contribution was the research carried out by Dr P J Klopper's Prison Research Group in well-controlled studies on long-term prisoners who volunteered to participate.

In 1965 Dr J J Theron, head of the Toxicology Division of the National Nutrition Research Institute, was appointed director of the institute in succession to Dr Quass who left to take up an appointment as general manager of the then newly established Southern Oil Exploration Corporation (Soekor).

The discovery that the toxins produced by a certain mould, *Aspergillus flavus*, growing on legumes and grain were not only very poisonous but also carcinogenic, sparked off an intensive study in the 1960s of toxin-forming fungi on foodstuffs. The CSIR was well-placed to make an effective contribution – the Microbiology Research Group identifying toxin-bearing fungal strains, the NCRL isolating and identifying the toxic components and working out analytical techniques, and the NNRI's Toxicology Division determining the toxicity of these substances and studying their role in the development of cancer.

The close association between the NNRI and the Microbiology Research Group was an advantage, particularly because of the increasing recognition of the importance of micro-organisms in biological food-processing and of the potential deleterious effects of contamination of foods by moulds. For nine years, from 1960 onwards, the Microbiology Research Group studied yeasts to contribute data for the compilation of a second revised edition of a book entitled *The Yeasts*, edited by J Lodder. This monograph, which was published in 1970, covered the taxonomy of 39 genera and 350 species and material was supplied by 13 taxonomists from several countries. About a quarter of the data of specific interest to manufacturers of fermentation products was contributed by the CSIR's Microbiology Research Group under Dr J P van der Walt.

With the establishment of the Medical Research Council (MRC) in 1969, the divisions of the NNRI concerned with research on nutritional diseases, i.e. physiological chemistry, toxicology, field studies and its clinics at the H F Verwoerd Hospital were transferred to the Nutritional Diseases Research Institute of the MRC. The director of the NNRI, Dr J J Theron, was appointed executive vice-president of the newly constituted MRC and Mr J P de Wit, assistant director of the former NNRI, was appointed director of a new National Food Research Institute comprising essentially the Food Science and Technology Branch of the former NNRI and the Microbiology Research Group.

The National Food Research Institute was organized into three research divisions: food technology, food chemistry and biological evaluation. Responsibility for the management of the Sorghum Beer Unit was transferred from the NCRL to the NFRI in 1974.

At this time the institute's activities became more strongly orientated towards fields such as food processing, cereal technology and biochemistry, food packaging and storage, flavour chemistry, food microbiology, food



Dr J J Theron
Director, National Nutrition
Research Institute, 1965-1969

*Microbiology
Research Group*



Mr J P de Wit
Director, National Food Research
Institute, 1955-1964

*National Food
Research Institute*

Biological evaluation

analysis, food chemistry and fermentation processes. Biological studies of nutrients in foods and diets were continued under Dr J J Dreyer, head of the Biological Evaluation Division for 32 years, particular attention being given to the updating of biometrical techniques for the assessment of nutritive value.

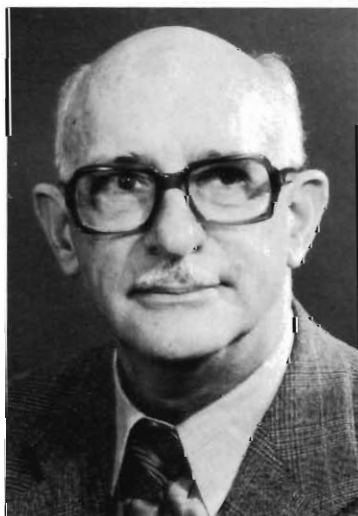
Over the years the institute acquired a wide range of small-scale (pilot plant) food-processing equipment which because of the limited market was very expensive. Through the availability of this facility food processing companies could evaluate their product and process development projects at a much lower cost. Good use was made of this facility by the Horticultural Research Institute of the Department of Agricultural Technical Services in the evaluation of experimental varieties of vegetables developed for processing, such as canning, freezing and dehydration. In this way suitability of new varieties for processing could be evaluated without incurring the cost of stopping industrial production to test large amounts of material.

Analytical techniques

New faster, computer-linked instrumental techniques were developed for the analysis of large volumes of foodstuffs to determine the quantity of the wide range of nutrients present - protein, fat, carbohydrates, fibres, minerals and vitamins - as well as other substances of importance in the study of foods. Because of the many volatile chemicals which contribute to the flavour of food, sophisticated methods for their study were developed. Simple, inexpensive apparatus was developed to extract these aromatic compounds at room temperature and improved methods of coating the inner wall of glass capillary tubing were devised to separate complex mixtures of flavour components by gas chromatography. An interesting offshoot of the Food Chemistry Division under Mr A S Wehmeyer was his research into the nutrient contents of various wild indigenous edible plants, such as the fruit of the marula tree and the 'soetwortel'.

In 1979 Mr de Wit was appointed a vice-president of the CSIR and Dr L Novellie, former assistant director of the institute and head of the Sorghum Beer Unit, became director of the NFRI. At that stage the institute comprised the divisions of food technology, fats and oils, biological evaluation, food chemistry, fermentation technology, the Microbiology Research Group and the Sorghum Beer Unit. In the ensuing period fermentation technology based on the expertise acquired by the Sorghum Beer Unit became a strong field of interest.

While each of the five directors left his own stamp on the institute, the most significant shifts in emphasis were in response to the changing demands of the time. The emergence of the Nutrition Society of Southern Africa and, in particular, the South African Association of Food Science and Technology, one of the strongest scientific and technical societies in the country, reflected during this period the contribution of the institute and the growing technological sophistication of the food-processing industry.



Dr L Novellie
Director, National Food Research
Institute, from 1979
(Chief Director from 1983)

SORGHUM BEER

Research in the Biochemistry Division of the National Chemical Research Laboratory into the malting of sorghum and its use in the brewing of

sorghum beer, a traditional beverage of the black people of southern Africa, won the support of the Institute of Administrators of Non-European Affairs in the form of an industrial research fellowship established in 1955. In 1959 the Institute of Administrators recommended that municipalities should contribute 0,1 per cent of the sales value of the production of their breweries to the fellowship fund. At that time it was estimated that the production of sorghum beer by municipalities was about 40 million gallons a year.

The Sorghum Beer Act (No. 63 of 1962) established a compulsory research levy and a research fund, the levy being fixed at 0,75 per cent of the value of beer sales. With financial support now assured, a Sorghum Beer Research Unit was set up within the NCRL. By 1967 production had increased to 140 million gallons a year and the funding of research and development amounted to R114 000 a year. Two years later production was estimated at 181 million gallons with a sales value of R31,8 million. It is reasonable to assume that much of this rapid increase in consumption could be attributed to the research and development which limited rising costs and raised the quality of the product.

In 1972 the activities of the Sorghum Beer Research Unit were considerably extended and its budget, derived from the levy on sales, increased. Not only was research expanded, but it also became more technologically oriented. For example, research and development undertaken by the Chemical Engineering Research Group on behalf of the Sorghum Beer Unit resulted in a number of major improvements in brewing technology. These included replacement of coarse malt by finely ground malt, which reduced unnecessary losses of malt; the introduction of plate heat-exchangers to improve heat economy, hygiene and flexibility of operation; and the development of a continuous mixer to transport slurries of grit or malt to replace the expensive and troublesome batch mixing tanks. This represented a significant contribution to the upgrading of a traditional home industry into a modern, sophisticated process industry.

A crisis in the sorghum beer industry arose as a result of the introduction of new varieties of sorghum which, although they gave excellent yields, did not share the ability of the traditional sorghums to produce good brewing malts. These problems were overcome by the development of a treatment which made possible the use of these new cultivars, including birdproof sorghums, a class previously unsuited for beer making.

The unit also became more directly concerned with consultative and service activities. Through representation on a committee set up by Parliament to advise the department concerned on the sorghum beer industry, the staff became closely involved in all aspects of the planning, erection and commissioning of new breweries and, in co-operation with the Techno-Economics Division, in the all-important question of rationalization of the brewing industry. With a view to upgrading technical management in the industry and more effective transfer of technology, the staff of the unit co-operated with the Pretoria College for Advanced Technical Education in the introduction of courses for a National Diploma in Brewing Technology.

In 1974 the unit, under Dr L Novellie, was physically transferred to the National Food Research Institute, which also assumed responsibility for

*Sorghum Beer
Research Unit*

*Improvements in
brewing technology*

Training

administering the unit. A Techno-Economics Division, established in that institute in the same year, undertook cost and feasibility studies and market surveys for the sorghum beer industry, and investigated the transportation of sorghum beer. In 1976 it was reported that 600 million litres of sorghum beer, packaged in non-returnable containers made from imported food grade board at a cost of R12 million a year, were sold in South Africa. Because of litter and other problems associated with the distribution and marketing of sorghum beer, the brewing industry became interested in returnable containers. Research by the CSIR, leading to a collaborative development project with local packaging manufacturers, resulted in the design of returnable containers made from locally produced high-density polyethylene. These containers met the requirements of cleanability, ease of mechanical handling, low-cost mass production, durability and improved product image. Moreover, marketing tests indicated that they were acceptable to the consumers.

The developments which have been described reflect the significant contribution made by the CSIR to the upgrading of the product of the so-called 'beerhalls', which at one time had fallen into some disrepute, into a high-quality, healthy, indigenous beer, produced, packaged and marketed by modern sophisticated technology.

WATER

With its limited, variable and unevenly distributed rainfall and few permanent streams, problems of water supply have always loomed large in South Africa, a situation aggravated by the threat of pollution following rapid urban and industrial development after the Second World War. The CSIR, aware of the need for research on water and effluent treatment, received representations from the professional body known as the Institute for Sewage Purification, which later came to be known as the Institute for Water Pollution Control. This body stressed the need for organized and centrally co-ordinated research.

Water Treatment Research Unit

Taking into account the many interests involved, including government departments and provincial and local authorities, the CSIR decided in 1948 to establish a Water Treatment Research Unit within the framework of the National Chemical Research Laboratory. Dr H Wilson, retired chief city biochemist of Johannesburg, was appointed temporary head with Mr (later Dr) G J Stander, former city biochemist of East London, as assistant head. Temporary accommodation was provided by the City Council of Johannesburg at the Klipspruit Sewage Works. The establishment of this unit was apparently an exploratory move, but it is evident that Mr Stander, with his enthusiasm and initiative, soon identified the key role which the CSIR could play in this field.

In 1950 he was appointed head of the unit, Dr Wilson being retained as adviser. Under his vigorous leadership the unit became a division of the NCRL with a staff of 12. At this stage it moved to prefabricated huts on the campus of the University of the Witwatersrand. By 1955 its scope had expanded to such an extent that a separate National Advisory Committee



The front entrance of the National Institute for Water Research photographed from the northern wing still under construction at the time.

for Water Research was appointed by the CSIR. In 1958, the division, with its staff of 42, was hived off from the NCRL to form a separate National Institute for Water Research (NIWR) under Dr G J Stander as director and the new institute moved to its own building on the Scientia site.

The growth and development of water research under the CSIR can be traced back to the original terms of reference of the Water Treatment Research Unit when it was set up in 1948. Among its objectives were the following:

- To provide supporting services required by the central authorities responsible for planning the development of water resources.
- To provide services to industries and local authorities on problems arising out of the need to meet quality standards for effluents.
- To undertake fundamental research into water treatment processes.

Initially the unit was hampered by the lack of a coherent national policy in this field. Legislation on water pollution was still embodied in four overlapping Acts and there were no effective mechanisms for their implementation such as regulations, standards and an inspectorate.

In 1954 a select committee was appointed to investigate the revision and consolidation of the country's water laws. The recommendations of the committee were subsequently embodied in the Water Act, No. 54 of 1956. In terms of the Act, standards for effluents drawn up by the South African Bureau of Standards were promulgated in 1962 and their enforcement became a function of the Department of Water Affairs. Industrial firms failing to meet these requirements were allowed a specified period in which to rectify the situation, and the NIWR expanded its facilities to be in a position to assist them.

The original research unit had already provided an illustration of this kind of assistance to industry when it carried out research on the anaerobic digestion of effluents from fermentation industries on behalf of the Germis-

*National Institute for
Water Research*



Dr G J Stander
Director, National Institute for
Water Research, 1958-1971

*Anaerobic digestion
of effluents*

ton Industries Association, alcohol producers in Natal and wine distillers in the Cape. Expertise in anaerobic digestion was developed and applied successfully in the treatment of effluent from a starch factory through research conducted in collaboration with the Municipality of Bellville, Cape. Dr Stander was awarded a doctorate in 1951 for his research in this project. Once the potential had been demonstrated, the NIWR continued with research and development to make the process as effective as possible, and in co-operation with several municipalities, pilot and full-scale plants were developed and operated. Many of these systems contributed effectively to reducing the organic pollution of rivers.

Re-use of water

The Water Research Division was commissioned in 1954 to advise on the water and effluent treatment system of the first Sasol plant which was being designed and developed for the production of oil from coal. A member of Sasol's staff was seconded to the division and was sent overseas to gather the latest information on effluent management. The design which was eventually adopted made provision for the greatest possible re-use of water in a cascade system, with the hydraulic handling of ash in the final stage. At the same time, by-products such as raw materials for the production of fertilisers, insecticides, disinfectants and plastics were recovered from the effluents. Similar economies in the use of water were later achieved by other waterintensive industries such as breweries and the chemical, steel and pulp and paper industries.

Stream pollution

In the early 1950s another study undertaken by the Water Research Division demonstrated that the main sources of pollution in streams draining into the Vaal Barrage from the southern Witwatersrand came from the mine properties. The Chamber of Mines agreed to tackle the problem in consultation with the CSIR. Detailed surveys by the Chamber revealed that the pollution was caused by oxidation of pyrite in the slimes dams and mine dumps. After a thorough investigation, it was concluded that the best way to stabilize the surface of the dumps was by vegetation. This not only prevented stream pollution but it greatly improved the environment of Johannesburg.

Subsequently, with a view to establishing biological/chemical norms for the evaluation of the levels of pollution and identifying the causes, surveys of all the country's major river systems were undertaken, starting with the Berg River in the western Cape.

Purified sewage effluent

From the outset priority was given to basic research into processes for the treatment of water and sewage. Facilities for pilot plants were made available to the original Water Treatment Research Unit at the Daspoort sewage works in Pretoria and the Cydna sewage works in Johannesburg. It was established that approximately two thirds of the water used in major towns or cities eventually landed up in the sewage works, and that purified sewage effluent could provide a significant source of water for industrial use such as for cooling purposes in industry.

Investigations into practical methods of purifying sewage effluent for unrestricted re-use subsequently became one of the institute's main projects. Possibly the most outstanding achievement of the NIWR was the development and application of technological processes for the recovery of drinking water from sewage at Windhoek. This project was initiated at the



The water reclamation plant near Windhoek in South West Africa.

request of the Windhoek City Council when it became apparent that the city's water supply would have to be supplemented. A team from the NIWR and the City Engineer's Department conducted intensive investigations on a pilot-plant scale between 1962 and 1965. Based on this work a full-scale 4 500 m³/d reclamation plant was designed and brought into operation by a South African firm of consulting engineers according to criteria of the NIWR.

The reclaimed water was fed into the supply from the Goreangab Dam and constituted 22 to 27 per cent of the city's drinking water. The Windhoek plant which could fairly be claimed to be a 'world first' was officially opened by the Prime Minister of South Africa on 21 January 1969, and the combined team received the National Award of the Associated Scientific and Technical Societies of South Africa.

Further development work continued in the main laboratories and Daspoort experimental site in Pretoria. In 1970 a large-scale 4 500 m³/d experimental water reclamation plant was commissioned at Daspoort. The plant, which was named after Dr Stander, was operated from 1971 to 1979 as a research and demonstration unit and contributed much to the acceptance of water re-use in South Africa, particularly as a result of the extensive quality testing which could be carried out under strictly controlled conditions. With improved processes which were developed, the production costs of the final water (30 c/m³ for a 4 500 m³/d plant) could be curtailed in spite of normal rising unit costs. Procedures were also developed for regenerating the costly imported activated carbon used in the reclamation process at a quarter of the cost of the imported product. It was estimated that, with a larger plant

The experimental Stander Water Reclamation Plant at Daspoort in Pretoria. The plant was named after Dr G J Stander, Director of the NIWR.



(50 000 m³/d), drinking water could be produced for 12,5 c/m³. By 1979, when the Daspoort plant had been in operation for seven years, a new agreement was concluded between the CSIR, the City Council of Pretoria and the Water Research Commission (which had partly financed this operation). The agreement provided for the City Council to operate the reclamation plant at Daspoort on loan as a production unit with the CSIR acting in an advisory capacity.

Research on the unit processes was continued by the CSIR on a laboratory and pilot scale. The results of this research were used to improve the efficiency of the Windhoek plant. When the City Council of Windhoek had to extend the sewage treatment works in 1978, it was decided to use an activated sludge process. As this yielded an effluent with a low ammonia content, the sewage works were modified and continued to operate successfully without the use of ammonia scrubbing towers.

The processes which have been described served only to remove organic matter from effluents. After repeated recycling, however, the concentration of mineral salts becomes unacceptably high. With financial support from the Water Research Commission, the NIWR investigated the possibility of using reverse osmosis for reducing the mineral content of recycled water. It was found to be technologically feasible and to yield water of better quality at a slightly higher cost than that produced by more sophisticated physical-chemical processes.

Water reclamation was also successfully applied by major industries. For example, two large pulp and paper factories installed their own plants for the reclamation of process water from purified sewage.

In 1979 the results of research during the previous decade on the reclamation of drinking water from purified sewage effluent were published under the title *Manual for Water Renovation and Reclamation*. The general principles involved in water reclamation were reviewed and process and engineering criteria described. In 1981 a revised edition was published with financial support from the Water Research Commission.

Research aimed at producing a hygienically acceptable compost from municipal waste with the addition of sewage sludge was started in 1955 with support from the Soil Conservation Council. Interest in this possibility was particularly keen in the western Cape where there was a need for organic fertilizers. The results achieved with the operation of a mechanized experimental plant, which was brought into operation at Daspoort in Pretoria, were published in 1964. As a result, several municipalities decided to instal full-scale composting plants which were evaluated by the NIWR in co-operation with the Department of Agriculture.

In the early 1970s the excessive growth of algae and other effects of pollution in dams, resulting from enrichment of water with plant nutrients such as nitrogen and phosphates (eutrophication), became an increasing cause for concern. With financial support from the Water Research Commission, these problems were investigated by the NIWR's Division of Fresh Water Biology (later Limnology). One of the results was a new formula based on the intensity of algal growth, expressed as the chlorophyll a-concentration, to correlate the eutrophication level of South African dams with phosphate load. As a result of an intensive study of the Hartbeespoort Dam, mathematical models of the interaction between biological and chemical components were developed for use in the management of South African dams.

Apart from their practical value, these activities played a significant role in stimulating the formation of research groups, particularly at universities, in the fields of limnology, marine biology and the environmental aspects of coastal engineering.

Parallel with this work, the NIWR directed its efforts to the development of processes for the removal of excess plant nutrients such as phosphorus and nitrogen compounds from industrial and sewage effluents before discharge into streams and dams. This research and development programme resulted in a purely biological process, the Bardenpho, which was patented internationally in 1974. By 1983, 30 sewage treatment plants in South Africa were based on the principles of the Bardenpho process, although some of them were still encountering operating problems. Once the appropriate technology became available, new standards for nutrients in effluents could be set by the authorities, and local authorities, for their part, could select the technologies most suitable for their circumstances.

To take advantage of expensive modern equipment and associated sophisticated analytical techniques, the NIWR concentrated its physical/chemical and biological analysis services in a Water Quality Division in 1971. Methods developed by this division for monitoring the quality of drinking water

Composting of municipal waste

Eutrophication

Analytical techniques

have been accepted internationally on the grounds of their accuracy and reliability. This applied particularly to research on the virology of water. The outstanding quality of this work contributed greatly to the acceptance of drinking water from purified sewage. Biological methods were also developed for the detection of poisonous and carcinogenic substances in water.

Biological evaluation

As chemical analyses are expensive and time-consuming, attention was directed to biological methods of obtaining qualitative indications of the presence of substances in water that posed a potential threat to health. As fish are particularly sensitive to changes in the water environment they are most suitable indicators of pollution. In 1974 a continuous automatic system for monitoring the toxicity of water was developed by the institute. It was based on the breathing rate and movement of fish which were monitored by a system of electronic sensors, developed by the National Electrical Engineering Research Institute of the CSIR with provision for continuous recording and an alarm system. By 1983 installations based on this system were being used in Windhoek to safeguard the quality of drinking water reclaimed from purified sewage. It was also used by two major industrial undertakings in South Africa to monitor the quality of their effluents and by industries in the USA, Britain, Switzerland and the Netherlands.

The institute undertook a country-wide survey of diatoms (microscopic single-celled algae with species having distinctive silica patterns which are a reliable indicator of water quality) to provide a thorough knowledge of the ecological requirements and relationships of each species. The leader of this project, Dr B J Cholnoky, undertook the massive task of compiling a reference index to the taxonomy of all known species of diatoms in Africa. To make this information more readily available the institute published a manual under the title *The Diatom Flora of Southern Africa*, the first volume of which appeared in 1976 and which became a standard work of reference world-wide.

From the beginning attention was given to ensuring access to world-wide sources of published information and to maintaining contact with leading workers in other countries. Regional laboratories in Durban, Bellville, Bloemfontein and Windhoek served as focal points for research and development which were geared to the short and long-term needs of provincial and local authorities, public bodies and industries.

Estuary and beach pollution

The Natal Regional Laboratory in Durban gave particular attention to bacteriological and chemical norms for the monitoring of the levels of pollution in seawater and to the design and management of marine outfalls for the disposal of effluents in the sea. From 1974 onwards the Laboratory co-operated with the CSIR's National Research Institute for Oceanology and other bodies in an extended survey of pollution of river mouths and beaches along the South African coast. The NIWR was specifically responsible for the coast from Kosi Bay in the north to the Buffalo River mouth at East London. This survey formed part of an international seawater pollution research programme.

The regional laboratory in Bellville was particularly concerned with the anaerobic digestion of industrial effluents with a heavy organic load, the composting of municipal waste with sewage sludge, and methods of storing and recovering purified sewage effluent.

During the 1960s the institute began a comprehensive systematic investigation into the possibility of supplementing the water supplies available to the metropolitan areas of the Cape Peninsula by feeding purified sewage effluent into the sand aquifer of the Cape Flats area for storage and subsequent withdrawal. One of the objectives of this project, which was supported by the Water Research Commission, was the development of a mathematical model of groundwater movements in the area for possible use as an aid to the management of the water potential of the region. When sufficient data had been obtained from extensive geophysical investigations and a borehole network – work done in collaboration with all the relevant authorities – the model was calibrated and made available to the Water Research Commission as a predictor. In undertaking this project, which was considered to be of great potential significance for the development and management of water resources in the arid west coast region of South Africa, the NIWR could draw on 20 years of experience of similar investigations in the charting of underground water quality and movement in South West Africa.

The reclamation of water from sewage at Windhoek has been described in some detail. In another major project a survey covering the whole of South West Africa was undertaken to provide reliable data on ground water from borehole and other sources for planning purposes and for monitoring changes in quality and supply. This entailed travel over many thousands of kilometres on roads of every imaginable standard. The data were processed by computer for the production of a four-colour map showing dissolved solids, sulphate, nitrate and fluoride content of ground water. This huge project was completed in 1982. As an extension of the institute's laboratory research on the evaluation of commercially available systems for the desalination of surface and ground water, five prototypes of simple solar distillation units for the production of drinking water from brackish water on farms were installed in various places in South West Africa to provide operating data. In addition a 10 m³/d ion exchange unit for the removal of nitrates was successfully operated at Aroab in 1977, and successful trials were conducted with a 110 m³/d desalination plant at Swakopmund.

With South West Africa moving towards independence and the laboratory services of the SWA Directorate of Water Affairs able to meet local research requirements, the Institute's regional laboratory in Windhoek was closed in 1982. Specialized laboratory services, however, continued to be provided from Pretoria under contract.

During the 1970s increasing attention was directed to the needs of the developing peoples of southern Africa. Contracts were entered into to provide technical training and supervisory and advisory services on the operation of water and sewage purification plants. Simple standard designs were drawn up for plants particularly suited to areas lacking trained personnel and facilities; and the Orbal sewage treatment plant, designed for

Cape aquifer project

Ground water data

Waste water purification for small communities

the purification of waste water in small communities, was developed in collaboration with the South African Inventions Development Corporation as the holder of the patent rights.

Since purification plants depend for best results on trained operating staff and technicians, the institute helped to develop syllabuses for the training of water-care works operators at technical colleges and technikons, incorporating features especially applicable to southern African conditions.

A separate Division for Technological Application was set up in 1971 to undertake, among other things, surveys of water use and effluent management by factories. Technical manuals for specific sectors of South African industry, such as meat, textiles, milk, wine, plating and anodising, were published.

At the same time the NIWR undertook several major research contracts for individual companies. It also encouraged research by industry itself and by the 1980s several large concerns were engaged in research on effluent treatment, including Sasol, Iscor, AECI and Escom. In addition, several universities had established water research groups with which the NIWR worked in close collaboration.

*Current Literature
on Water*

A computerized current-awareness service known as *Current Literature on Water*, which was produced by the Institute in collaboration with the CSIR's Centre for Scientific and Technical Information, provided a basis for the establishment in 1975 of the South African Water Information Centre, operated by CSTI under contract to the Water Research Commission. This centre established a computerized data base WATERLIT for selective dissemination of information and a retrospective literature searching service.

Through its close association with the International Association on Water Pollution Research (IAWPR) and the International Water Supply Association, the institute played a leading role in both local and international water forums. Dr Stander was elected vice-president of IAWPR on its foundation in 1965 and president in 1968 a position he held for four consecutive two-year terms of office. In June 1977 the South African and Israeli National Committees of the IAWPR held a conference in Johannesburg on advanced treatment and reclamation of waste water. The institute was intimately involved in the organization of the conference, which attracted some 50 delegates from overseas, out of an attendance of 250. Sixteen of the papers read were by members of the institute's staff. The IAWPR subsequently held its 11th biennial conference in 1982 in Cape Town where the NIWR played a major role in arranging and conducting the conference.

It was evident the NIWR had won international recognition for its achievements in the development and application of new and improved processes for the purification and desalination of water and effluents, water reclamation for both domestic and industrial re-use, as well as the prevention of pollution of rivers, dams and the sea. As a result of the widespread application of these processes, South Africa was in a position to make the best use of the available water resources in a time of rapid industrial and population growth.



Dr G G Cillié
Director, National Institute for
Water Research, from 1971
(Chief Director 1983-1984)

Much of the success of the NIWR could be attributed to Stander's holistic approach to water research. He inspired the concept of the reclamation of water for unrestricted re-use, and for many years all the activities of the institute were geared towards the achievement of this goal. In 1966 he was appointed to the Commission of Inquiry into Water Affairs which recommended the establishment of the Water Research Commission (WRC) with a responsibility for co-ordinating and financing water research in the national interest. In 1971 he left the CSIR to become vice-chairman and chief executive officer of this body.

He was succeeded as director by Dr G G Cillié, former head of the institutes' regional laboratory in Bellville. Under his leadership the institute continued to make further contributions to the development, improvement and refinement of processes and techniques for water treatment and pollution control, as reflected in the foregoing review. On Dr Cillié's retirement from the CSIR in April 1984, Dr D F Toerien, formerly director of the Institute of Environmental Studies at the University of the Orange Free State, took over as chief director of the NIWR.



Dr D F Toerien
Chief Director, National Institute
for Water Research, from 1984

TEXTILES

Wool has always been one of South Africa's most important agricultural export products. Vast tracts of the country's semiarid hinterland are, in fact, suited to little else than the production of wool. The merino breed of wool sheep, which is particularly suited to these rugged climatic conditions, was developed and improved by a sturdy band of independent farmers, organized through the National Wool Growers' Association and the South African Wool Board. Justly proud of their product, 'Pure New Wool' became to them an emotive slogan.

In view of the limited domestic market, the bulk of the wool clip was exported, and research by the Department of Agriculture was concerned mainly with animal production, such as breeding and nutrition in relation to wool quality and yield. In this regard, limited laboratory research was undertaken into the chemical composition of wool in relation to its physical properties, and into the by-products of wool, such as wool-grease and lanolin.

The war years gave an impetus to the local processing of wool, notably wool-washing, and the production of woollen products such as blankets and more sophisticated worsted fabrics. The development of the local textile industry was favoured not only on the grounds of sentiment but more particularly as a labour intensive industry providing jobs for the less developed sections of the population. By 1945 some 10 per cent of the national clip was being processed locally. While these developments were taking place in South Africa, spectacular international advances in chemical technology, particularly in the production of synthetic textile fibres, posed a threat to the traditional markets for natural fibres.

A visit in 1947 by Professor J B Speakman of the Textile Department, Leeds University, who was at that time regarded as the doyen of textile research in the world, led to a new phase in wool research in South Africa. Until then



The first accommodation of the SA Wool Textile Institute on the Rhodes University campus in Grahamstown.

research on sheep and wool had been confined almost entirely to work on sheep breeding at agricultural colleges such as Glen and Grootfontein, on wool fibres and wool-grease at Onderstepoort and, somewhat sporadically, on allied problems by gifted individuals at the universities. Professor Speakman was quick to assess the importance of South Africa's rapidly developing wool textile industries. Established alongside the areas which produce some of the world's best fine wools, these processing industries opened up opportunities for research which could not have been realised in the older manufacturing countries. He recommended the establishment of a separate Wool Textile Institute to deal with technological problems and the co-ordination of this kind of research with biological research on sheep and wool.

Acting on his suggestion, the Wool Board asked the CSIR to co-operate with it in setting up an institute for research on wool processing. The CSIR agreed, subject to the involvement of the local wool textile manufacturing industries. When the financial support of the National Textile Manufacturers' Association and the National Association of Worsted Textile Manufacturers was secured an action committee, composed of representatives of these two bodies, the Wool Board and the CSIR, was set up by the CSIR. As an interim measure the action committee under Dr P J du Toit was responsible for the organization, management and finance of the institute, until its registration as an autonomous, non-profit company under the CSIR's industrial research association scheme.

It was agreed that the institute should be established at Rhodes University, Grahamstown, where a suitable building adjacent to the Leather Industries Research Institute could be rented from the university for ten years with the option to purchase. The institute would be conveniently placed near Port Elizabeth, one of the main centres of the wool industry.

The first staff members were appointed in 1951. They were Dr DP Veldsman, a research chemist from the Veterinary Research Institute at Onderstepoort, Dr P Grosberg, a mechanical engineer, and Mr C T MacDonald who had a master's degree in agriculture. Grosberg and MacDonald were sent almost immediately to Leeds University for a two-year course in textile technology, and in 1952 Dr Veldsman followed to do a year's postgraduate work. Mr R C Palmer, a principal scientific officer at the Wool Industries Research Association, Torridon, England, was appointed director of the institute on a three-year contract. He was one of the United Kingdom's three representatives on the technical committee of the International Wool Textile Organization and chairman of its committee on 'length and diameter of the wool fibre'. He arrived by sea in Port Elizabeth in May 1951, where he was met by Mr H Schauder, Chairman of the CSIR's Midland Regional Research Liaison Committee.

The institute got off to a slow start, hampered by limited funds, lack of facilities and equipment, and uncertainties about its permanent location. In addition, because of delays in its registration as a non-profit company, the institute could not be formally opened as the South African Wool Textile Research Institute (SAWTRI) until 18 June 1954. In these circumstances there were resignations among the staff and by mutual agreement Palmer's contract was not renewed. He left in August 1955 and was succeeded as director by Dr C C Kritzinger, chief research officer of the Leather Industries Research Institute.

The new director and Dr J H Moolman, chairman of the Wool Board and the institute's Board of Control, were asked to draw up a memorandum on the future location of SAWTRI. On the basis of their report it was decided to remain in Grahamstown and two additional buildings were bought and a new building was put up on adjacent land for research on the scouring, dyeing and finishing of wool.

Because of continuing concern at the slow progress of the institute, Professor Speakman was invited again to advise on its further development. His recommendations for an intensive programme of development for the ensuing three five-year periods until 1974 were presented to the board by the chairman and the director in September 1958. The main emphasis of this programme was again on co-ordinating the work of a biological nature on wool and mohair with the primary stages of processing and related fundamental aspects of the composition and structure of the fibres.

However, because of the impact made by synthetic fibres, circumstances in the wool industry were changing. The enormous demand for textiles following the Second World War resulted in an unprecedented rise in wool prices. This greatly facilitated penetration by the synthetic fibre industry into wool's traditional markets. Synthetic fibres were not only lower and more stable in price but delivery times were much shorter than they were for wool shipped from the countries of origin. No new machinery was required for their processing into fabrics and they also had tremendous appeal to the consumer because of their novel easy-care properties.

Early in the 1950s wool prices fell markedly but this did not bring about a rapid re-entry of wool into its former markets. Manufacturers and users had

*South African Wool
Textile Research
Institute*

Mohair included



Dr C C Kritzinger
Director, SA Wool Textile Research
Institute, from 1955-1963

come to prefer the synthetic fibres and wool was thus faced with the daunting task of recovering lost markets by overcoming its inherent processing disadvantages and enhancing its superior qualities so as to compete with synthetic fibres in all respects.

Recognizing that SAWTRI would have to reassess the scope of its activities to meet the challenges of the changing needs of the textile industry, the Wool Board, under its new chairman, Dr J G van der Wath, invited Sir Frederick White, former chairman of the Australian CSIRO, to visit South Africa and advise on the institute's future. In his report Sir Frederick emphasized the important contribution which South Africa could make to wool research, both internationally and nationally. He recommended that as one of the world's main producing countries exporting the bulk of its clip, South Africa's textile research should concentrate on supporting the promotion campaign of the International Wool Secretariat (IWS). Constant contact should be maintained with the secretariat to co-ordinate South African research with the international effort. The institute should be geared to supporting the country's young and developing textile industries by developing new techniques. South African scientists could make original contributions to the processing of wool, thus promoting the use of wool not only in South Africa but throughout the world.

Sir Frederick also recommended that in order to achieve these objectives SAWTRI should be managed directly by the CSIR. A subcommittee of the CSIR Council, consisting of the president and two other members, met representatives of the Board of Control of the institute in October 1962 to consider the implications of these recommendations. The subcommittee was in favour of the CSIR's taking over the institute with its assets and liabilities and SAWTRI was formally incorporated into the CSIR organization in 1964. The Wool and Mohair Boards and the manufacturers continued to contribute to the funding of the institute as before and on the insistence of the growers the CSIR gave an undertaking that the Institute's research would be devoted entirely to wool and mohair and blends of these fibres.

In the meantime, Dr Kritzinger had resigned to take up a post as manager of the Mohair Board, and Dr D P Veldsman, who had left the institute in 1959 to become research manager of a worsted manufacturing firm in Uitenhage, was appointed director of the institute in August 1963. In February of that year a subcommittee appointed by the Board of Control to investigate the suitability of the institute's location in Grahamstown recommended that it should move to Port Elizabeth. This was accepted and the CSIR subsequently received a generous offer from the Municipality of Port Elizabeth of a 60-hectare site beyond Summerstrand adjacent to the area reserved for the development of the University of Port Elizabeth and a College for Advanced Technical Education (Technikon). Construction of the institute's building started in 1965, and it was opened on 20 June 1967.

With its mandate extended to cover the entire field of wool processing, from the fibre to the cloth, encompassing both fundamental and applied research, SAWTRI was in a better position to meet its national and international commitments to the wool producer and wool industry. Separate divisions were formed for protein chemistry, textile physics, mechanical processing



Dr D P Veldsman
Director, South African Wool and
Textile Research Institute,
1964-1979

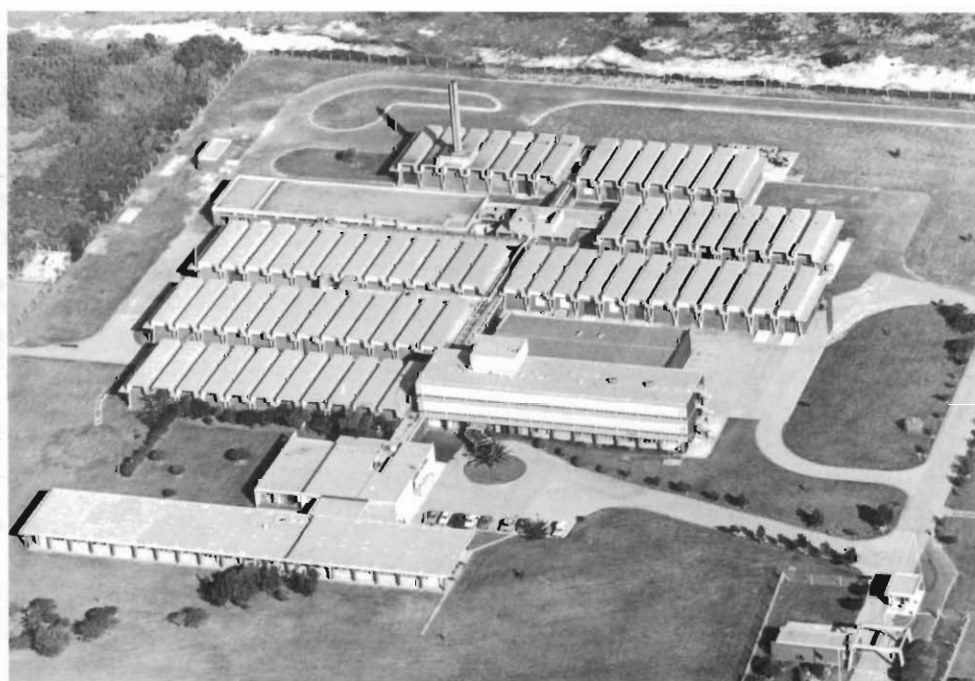
and dyeing and finishing, with a special section to deal with technical enquiries from the textile industry. In the processing field, investigations into aspects of scouring, carding, gilling, combing and knitting were expanded to include drawing, spinning and weaving. Closer collaboration was established with the technical division of the S A Wool Board (responsible for the objective measurement of raw wool and for the policing of the woolmark) when its laboratories moved to a site adjacent to the institute. In 1967, a four-year BSc course in textile technology was introduced at the University of Port Elizabeth, with the senior research staff of the institute as part-time lecturers and the director holding the position of professor extraordinary of textile science.

The next major step forward came in 1971 when the South African Wool Board, the executive of the National Wool Growers' Association, the Mohair Board and the CSIR decided that the scope of the institute should be extended to include research on all textiles, including synthetic fibres and blends of other fibres with wool and mohair. On 1 April 1971 SAWTRI became a national institute of the CSIR and its name was changed to the South African Wool and Textile Research Institute – which had the advantage of retaining the same acronymic title, i.e. SAWTRI.

This decision was of particular significance to cotton, which had previously received little technological attention in South Africa. In May 1974 the president of the CSIR, Dr C v d M Brink, officially opened a new cotton processing department. This heralded a new era in the institute's research. Whereas previously it had dealt only with animal fibres – wool and mohair and blends of these fibres – it now became fully operative as a national textile research institute, with cotton playing an important role in its

*A National Institute of
the CSIR for Wool and
Textile research*

Cotton processing



The new SAWTRI buildings adjacent to the technical division of the SA Wool Board in Port Elizabeth.



Dr D W F Turpie
Director, South African Wool
and Textile Research Institute,
from 1979
(Chief Director from 1983)

*An experimental
factory*

research programme. Close co-operation between SAWTRI and the South African cotton industry was established, with attention also being given to aspects peculiar to the subcontinent, notably Zimbabwe (then Rhodesia), Malawi and Swaziland. This co-operation included technical assistance to individual firms as well as projects such as the development of new fabrics and a techno-economic survey of the cotton manufacturing industry in one of these countries. SAWTRI assumed responsibility for testing various new cotton cultivars for spinning performance, the object being to ensure that only the best cultivars would be released for large-scale cultivation. Research into the processing differences between mechanically harvested and hand-picked cotton was undertaken on behalf of the Department of Agricultural Technical Services.

In 1979 Dr D P Veldsman, who had been director since 1963, resigned. Always a keen advocate of the blending of wool and mohair with other fibres, he played a key role in the institute's expansion to include cotton and non-wool fibres. He left to take up an appointment as Director of the Port Elizabeth Technikon, and was succeeded by Dr D W F Turpie, an assistant director of the institute who had extensive experience in the field of textile technology, both in industry and research. Turpie also succeeded Veldsman as professor extraordinary of textile science at the University of Port Elizabeth when the latter retired from this position at the end of June 1984.

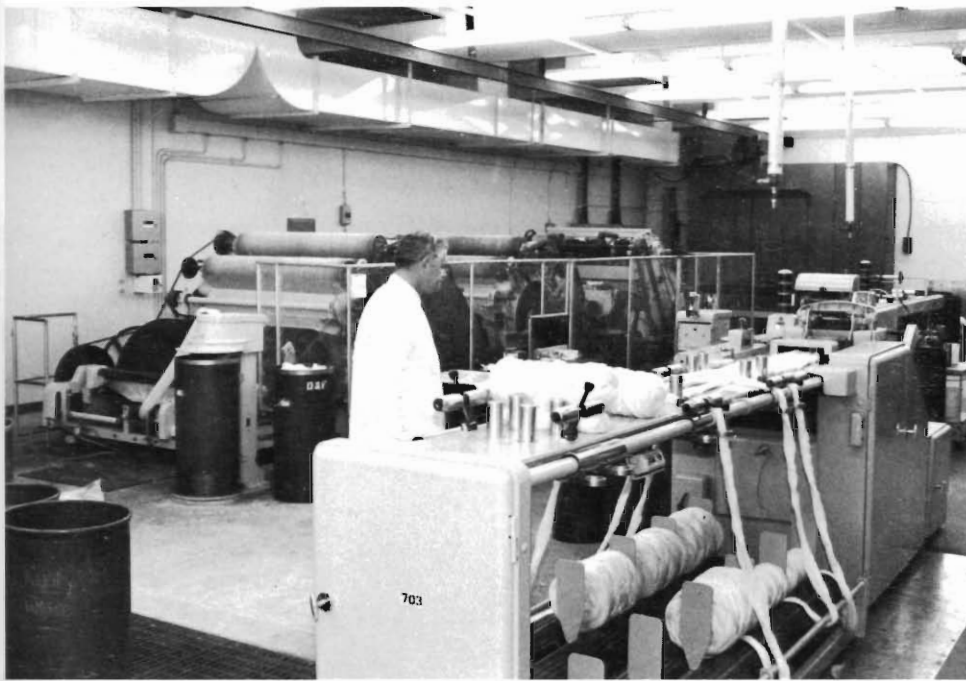
SAWTRI became a self-contained experimental factory operated in conjunction with well-equipped chemical, physical and testing laboratories. These facilities, encompassing the entire range of technologies for the processing of all types of textile fibres, from the raw material to the finished product on full-scale commercial machinery, were unique in South Africa if not in the world. With its own technical workshop and a department of machine development and innovation it was responsible for a number of important developments over the years.

The institute's comprehensive studies on the relationship between the properties and behaviour of wool and mohair fibres during textile processing and in the finished product, contributed greatly towards the better use of these natural fibres. They also provided a valuable feedback to the producer on the fibre characteristics of importance in textiles. Important work was also done on wool and mohair dyeing and finishing, and in the easy-care treatment of wool.

Research was done on the effects of mechanical picking and different ginning conditions on the properties and processing behaviour of locally grown cottons. Useful technical know-how and data were generated on cotton fibre properties, textile processing and yarn and fabric properties, and the interrelationship between the foregoing were clarified. Particular attention was given to the relatively new technology of open-end (rotor) spinning, and studies were undertaken to clarify the effects of cotton fibre structure and contaminants on dyeing behaviour.

The versatility of the institute's technological capability was illustrated in a project aimed at more efficient processing of phormium fibre and alternative uses for this product. The growing of *Phormium tenax* had been introduced in southern Africa to provide an alternative to jute in the manufacture

*Phormium tenax
processing*



Carding and gilling machinery for disentangling and aligning long fibres made up part of the research equipment in the SAWTRI laboratories.

of sacking material. However, changing market conditions created a need for alternative outlets and the institute demonstrated that by a simple process in which caustic soda and sodium hypochlorite were used this fibre could be bleached and softened and spun into yarns suitable for wall furnishings and other purposes with the additional possibility of blending it with synthetic fibres or cotton for clothes. However, the project had to be abandoned when government sponsorship was discontinued.

Throughout its existence, but more particularly in the 1980s, the institute did pioneering work on new technologies by evaluating them for the benefit of the local textile industry and building up technical know-how so important in the day-to-day use of such technologies. The techniques included radio frequency dyeing and finishing, foam dyeing and finishing, friction spinning, wrap spinning, and objective measurement of wool and cotton.

By 1985 SAWTRI was contributing towards the general effort in most countries to improve the technical efficiency and economy of manufacturing processes in the textile industry. The following are some examples of processes, equipment, machinery and instruments developed by the institute, many of which found application in local and overseas textile mills:

- The shrink-resist treatment of wool tops.
- Simultaneous dyeing and crease-resist finishing of cotton fabrics. Spinning relatively fine self-twist yarns from long-staple wool and mohair at high speed; this involved the introduction of two nearly invisible synthetic filaments into the yarn being spun, one as the core and the other wrapped around the yarn.
- An automatic feeding mechanism for ensuring a continuous flow of fibres in sliver form into gill-boxes at extremely high efficiencies. It is known as the Autocreel and was patented by the South African Inventions Development Corporation and licensed to a large Italian supplier of textile machinery.

- The SAWTRI yarn friction meter for the routine determination of the kinetic friction of a yarn.
- The SAWTRI SLD monitor for monitoring the linear density of slivers.
- The SAWTRI compressibility tester for simple and rapid testing of fibre bulk.
- The SAWTRI wrinklemeter used to quantify and characterize the degree of wrinkling of fabrics.
- The SAWTRI automatic staple length and strength tester for use in the objective measurement of raw wool.
- The SAWTRI yarn strength tester for measuring the number of isolated weak places in a yarn for efficient weaving in high-speed looms. This instrument, capable of 10 000 tests an hour, far exceeded the performance of the best available equipment anywhere.

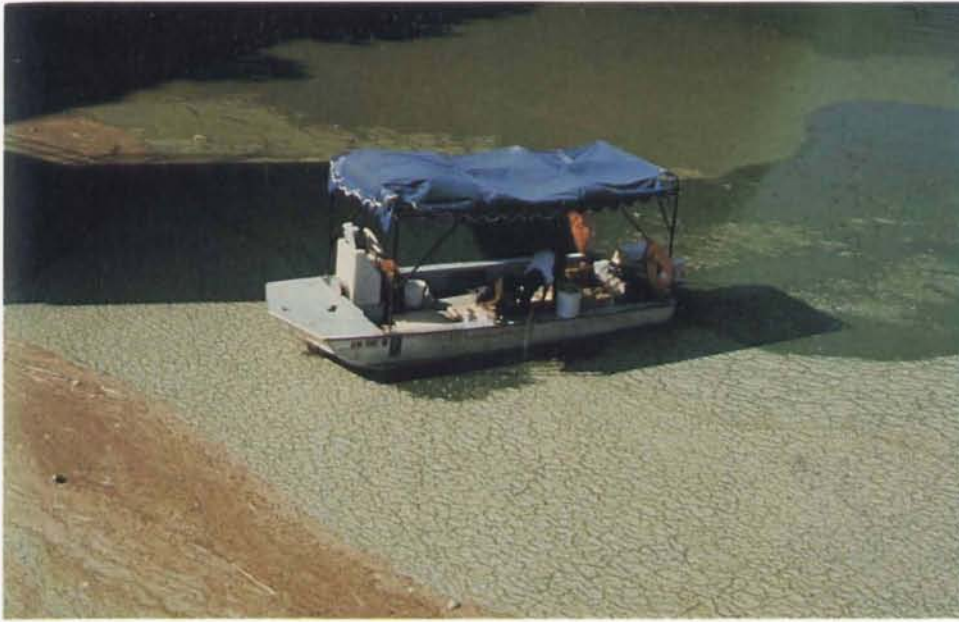
By 1985 SAWTRI had won international recognition as one of the leading centres of excellence in textile technology. This was reflected in the significant contributions of its researchers to international conferences and also by the number of participants from other countries in conferences and symposia organized by the institute. Prominent among these conferences were those on 'textile training in the Republic of South Africa' (1975), 'new developments in fabric manufacture' (1977), the sixth quinquennial international wool textile research conference (held in South Africa for the first time in 1980 and attended by 200 delegates from 17 countries), and a symposium on 'new technologies for cotton' (1982), the first of a planned four-yearly series of symposia on new technologies for textiles.

In addition to the distribution of some 800 technical and special reports to textile firms, research organizations, universities and individuals in 51 countries, the institute exchanged publications with 35 textile research organizations in 12 countries.

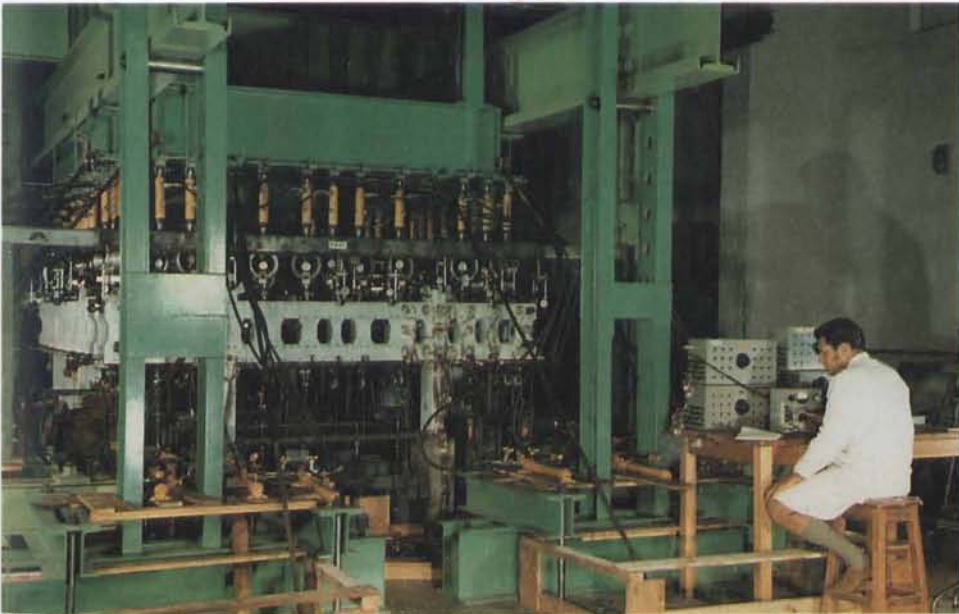
TIMBER

Natural forests are one of the few basic resources with which South Africa is not abundantly endowed. However, many areas, particularly the seaward slopes of the escarpments which rim the inland plateau, proved to be suitable for quick-growing exotic species of conifers as well as hardwoods such as eucalyptus and wattle. The introduction of these species was pioneered by the State in a vigorous programme of afforestation during the 1930s. Between 1922 and 1938 the area of State plantations increased from 39 055 to 137 393 hectares and large quantities of softwood sawlogs from State plantations became available in the late 1930s. Because the private sector was at that stage reluctant to become involved in sawmilling, the Department of Forestry was obliged to provide this service. The first State sawmill was established at Nelspruit in the eastern Transvaal in 1937.

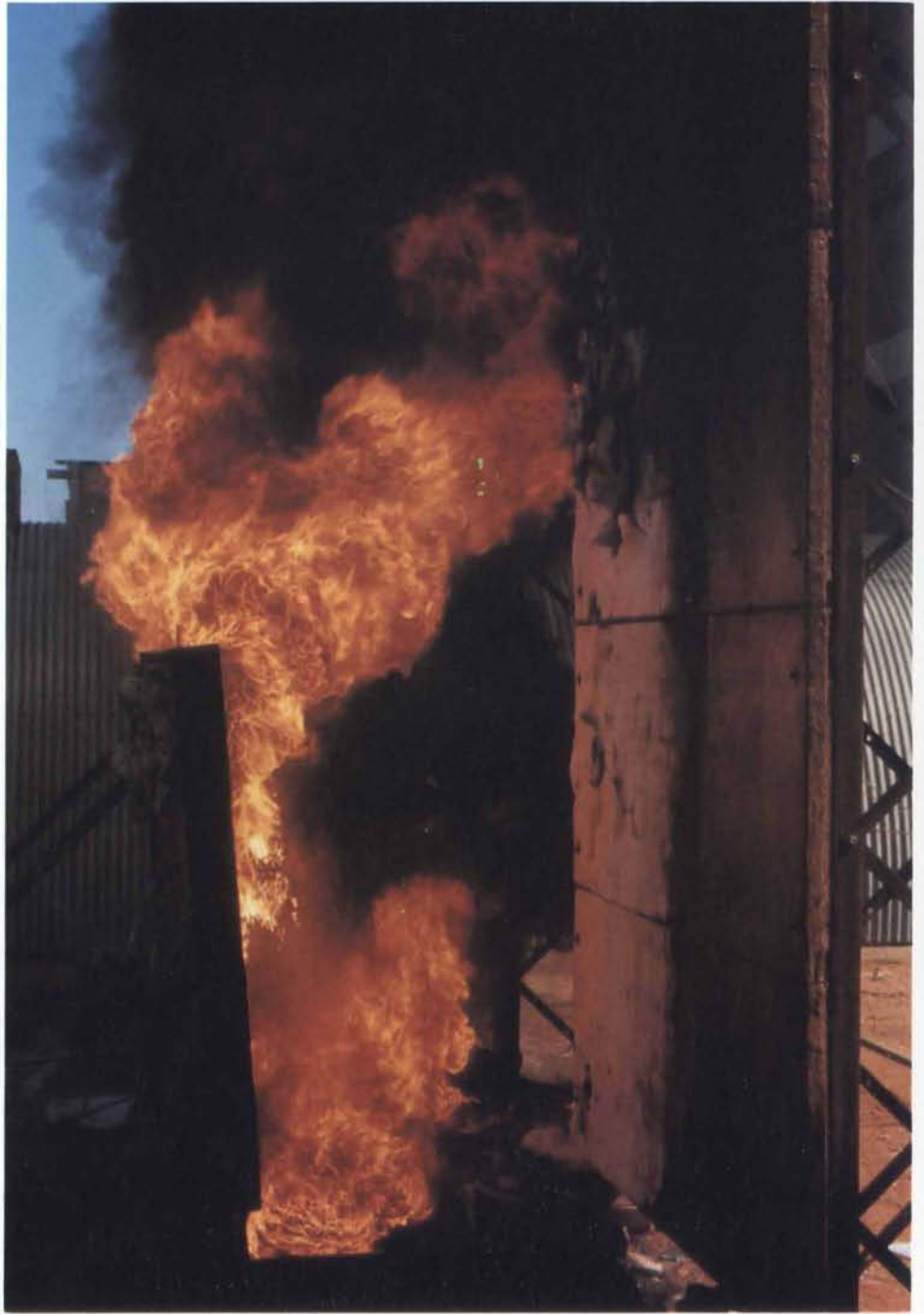
During the Second World War, the attitude of the private sector changed dramatically. Supplies of imported timber were cut off, and privately owned sawmills, as well as additional State sawmills and wood preservation plants sprang up in many parts of the country. After the war there was



A research craft of the National Institute for Water Research on the Hartbeespoort Dam near Pretoria where eutrophication and its effects on aquatic plant growth were studied.



Structural testing of a model of a building in the National Building Research Institute.



An inflammability test in progress
in the National Building Research
Institute's fire research facility.

an unprecedented boom in afforestation. The rate of planting by the Department of Forestry increased to more than 8 000 hectares a year, and large companies played a leading role in a vigorous afforestation campaign. A period of sustained growth in timber processing followed, which included sawmilling and the manufacture of veneer, pulp and paper products, mining timber, matches, rayon, pulp and composite board.

These developments owed much to the early initiatives of the Department of Forestry in establishing a research section in 1910 which, in 1919, was extended to include a Forest Products Institute. This institute was equipped to deal with all matters concerning the sawing and seasoning of timber, methods of impregnating timber with preservatives, physical and mechanical properties, and uses and identification of timber. The department also established a college for training foresters in the Cape (moved to Saasveld near George in 1932) and supported the development of a Faculty of Forestry at the University of Stellenbosch. For a time South Africa led the world the research development of man-made forests. In broad outline this was the situation in the forestry industries when the CSIR was being set up in 1945.

Research at this stage on forest products was being undertaken by the Department of Forestry, the University of Stellenbosch, the Timber Research Laboratory of the Chamber of Mines, and the newly established Wattle Research Institute in Pietermaritzburg. The private sector, represented by the South African Lumber Millers' and Shook Manufacturers' Association, proposed to the CSIR that it should form a body to do research geared to the interests of the industry as a whole and to co-ordinate existing research. In view of the heavy involvement of the State in forestry, the CSIR adopted a cautious attitude and suggested that the industry should consider establishing an autonomous co-operative industrial research institute under the CSIR's research association scheme. While these negotiations were in progress the rapidly developing national research institutes of the CSIR became increasingly in *ad hoc* contract studies of a mechanical, civil and chemical engineering nature on behalf of individual timber producers and users. Eventually the Lumber Millers' Association agreed to support a project of more limited scope through the CSIR's industrial research fellowship scheme and selected wooden packaging as a suitable topic for research.

By the mid 1950s three such fellowships were being supported at the CSIR by timber interests:

- A wooden packaging research fellowship in the Mechanical Engineering Research Institute, sponsored by the association, to investigate all aspects of the use of locally produced pinewood for the manufacture of wooden boxes for the fruit export industry.
- A pulp and paper research fellowship sponsored by SAPPI in the National Chemical Research Laboratory to investigate the pulp and paper-making properties of various commercially grown timber species and the effect of their age and growth rate on these properties.
- A chemicals from wood fellowship, also in the National Chemical Research Laboratory, sponsored by the Wattle Growers' Union, to investi-

A demand for timber research

Timber Unit



Dr D L Bosman
Director, National Timber Research
Institute, from 1976
(Chief Director 1983-1984)

National Timber Research Institute

gate the possibilities of processing wattle wood into chemical products (after the bark had been removed for the production of tanning extract).

In 1960 the CSIR, in addition to its research association and research fellowship schemes, decided to establish industrial research units within its organization as a means of providing a focal point for its research undertaken on behalf of specific sectors of industry. In accordance with this scheme, the Timber Unit was created as a separate entity with its own staff and research programme. However, as much of its work was concerned with the use of timber in buildings, it was housed and administered by the National Building Research Institute. The unit absorbed and expanded the work initiated by the wooden packaging research fellowship and assumed administrative responsibility for the pulp and paper fellowship, although until 1963 the research was conducted and directed by the National Chemical Research Laboratory. The research of the chemicals from wood fellowship was discontinued in 1960.

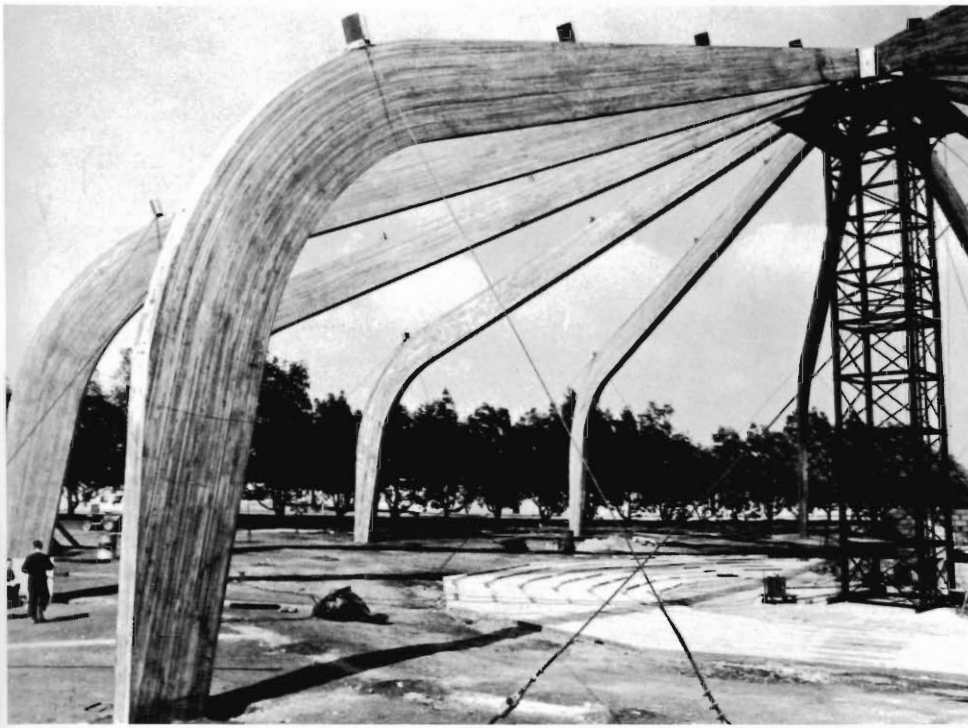
Other research on timber technology, such as that conducted by the NBRI and the Techno-Economics Division, was transferred to the unit. As a unit within the CSIR it was also able to draw on the full spectrum of the expertise available at the various institutes and laboratories.

Dr D L Bosman, a mechanical engineer, whose experience in timber research at the CSIR dated from 1955 with the establishment of the wooden packaging research fellowship, became head of the unit. Under his leadership an extensive programme of research and development on timber grading and laminated beams was initiated. In addition to the cost aspects, studies on timber housing included their structural stability and durability; their resistance to rain, heat, fire and insect and fungal attack; and protective coatings such as paint and varnish. The unit also did research on the better use of timber in other fields, such as the production of chemical and other products derived from timber.

In 1966 the Timber Unit was renamed the Timber Research Unit and became a separate entity independent of the NBRI and reporting directly to the executive of the CSIR. Research and development was organized in divisions for timber engineering, wood processing, pulp and paper, systems development, techno-economics and information, and in fact covered all the major disciplines within the wide field of forest products research.

In 1976 the unit, with Dr Bosman as director, and a staff of 75, became the National Timber Research Institute of the CSIR. This development was supported by the Forestry Council established as a statutory body in 1973 to administer funds from a levy on timber production for the joint purpose of timber promotion and the funding of research by various organizations including the CSIR.

At that stage timber research was being conducted in temporary premises on the CSIR site. In 1982, however, the institute moved into its own building on the CSIR site. In 1985 this building had to be extended to provide for research on wood preservation and drying, and for the Institute's experimental work on roof trusses, sawmilling, board products and finger-jointing.



Giant glulam beams form the sturdy skeleton of a church building near Benoni.

The activities of the institute were organized in the following three major groups, each under the supervision of a member of the directorate:

- Chemical technology, including research into the preservation of timber, pulp and paper, polymers, adhesives and resins.
- Wood technology, including the drying of softwoods and hardwoods, sawmilling, the use of wood residues, composite board products, glulam and glued end joints, systems management, timber economics and computer application.
- Engineering, including mechanical stress grading of timber and grading machines, roof trusses and timber frame houses.

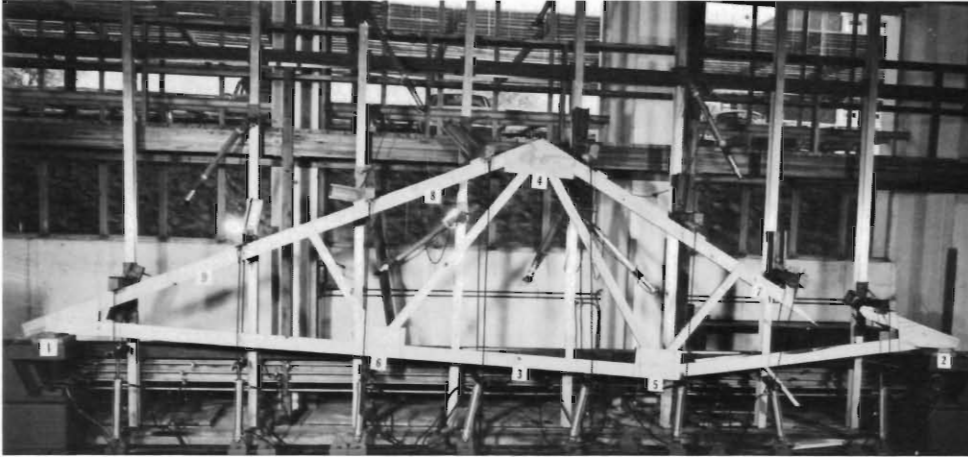
These broad programmes of research were conducted in close collaboration with the industry to ensure that the results were applied in processes and manufactured products acceptable to the user in terms of sophistication, quality and price. The following are selected examples of some of the achievements and advances made by the institute:

- Adhesives based on wattle and pine extracts to replace expensive and scarce imported chemicals for use in the manufacture of particleboard, plywood, glulam, fingerjoints and corrugated cardboard. The institute scored a scientific award in the USA in 1980 for this development.
- The determination of the thermo-mechanical pulp quality of South African softwood species, a project completed in 1982.
- A glulam and fingerjointing technology which made possible the use of short lengths of timber to build up beams of almost any possible dimension and form for construction purposes. The same technology was used in the manufacture of laminated shelving, railway sleepers and a wide range of products for outdoor and interior use. For the so-called 'honeymoon' fast-setting adhesive system for fingerjointing extensively used in South Africa and overseas, the institute received several national and international awards.

- The use of wood residues such as sawdust, shavings and chips in the production of wood-cement-sand composites in making light-weight building components with good thermal performance. With unskilled labour and low capital outlay, the recommended process was suitable for producing high-quality products.
- Fire retardants developed by the institute for the treatment of mining timber. A number of gold mines treated all timber used underground with these chemicals to improve safety and production.
- Improved treating techniques for copper-chrome-arsenate (CCA) wood preservative to solve the problem of sludges forming in the stock solution. The new treating process used for the application of both CCA and fire retardants also halved the treating time, and greatly improved the productivity of treating plants.
- A computerized mobile laboratory built up as a service to the sawmilling industry to improve the kilning practice as well as the overall efficiency of the timber drying process. With this laboratory it was possible to monitor the progress of the drying process in a manner never achieved before.
- Various computer programs such as the Simsaw program which was adapted to a minicomputer and used in sawmills in conjunction with the Prolog program to determine sawing patterns which best fit specific sawlogs to give the highest yield of timber for which the best market existed at the time.
- Updating the technology for the manufacture of producer gas from waste wood, the cleaning of the gas and the conversion of engines to operate on the gas.
- Mechanical stress-grading technology including a low-cost grading machine, the TRU timber grader, developed in the early 1970s to provide for the needs of local roof truss and glulam manufacturers. Improved models were subsequently developed, which proved to be reliable and efficient. By 1985 more than a hundred had been sold by the licensees and an automated version, the Trimag, became available in 1984.
- New designs for roof trusses based on strength-graded timber. These designs not only made increased spans possible but also used less timber.
- *Houtimtrend*, a publication compiled by the Timber Economics Division based on information collected from the sawn timber market, provided a digest of softwood sawn timber supply and demand statistics, including forecasts of anticipated trends.

The Institute set great store on international collaboration and several of the senior staff were office-bearers on international bodies, such as the International Union of Forestry Research Organizations (IUFRO) and the International Academy of Wood Science (IAWS). Symposia and conferences organized by the Institute attracted many experts from overseas to South Africa.

When he formally opened the institute's building in 1982, the Minister of Economic Affairs, Dr D J de Villiers, drew attention to the fact that the sales value of timber and timber products amounted to more than R950 million



The strength of roof trusses of a new design developed by the National Timber Research Institute being tested.

annually and approximately R1 600 million was invested in the growing and processing of timber. (However, between 1982 and 1985 these figures changed dramatically with the vast new investments made mainly by the pulp and paper industry at Ngodwana in the Eastern Transvaal and at Richards Bay. At the end of 1985 the total capital investment in the timber processing industry was estimated at R3 651 million and the total sales value of its end products for that year was R2 060 million.) At the same function Mr J B C Roetz, managing director of the Hans Merensky Foundation, expressed concern that, although the private sector owned 72 per cent of the commercial forests and 95 per cent of the processing industry, only 0,07 per cent of the total gross income of industry was spent on research and development. He added that if the industry wanted a greater say in research it should be prepared to provide more funds.

Dr D L Bosman, who had headed timber research at the CSIR from its early beginnings, left the CSIR in 1984 and was succeeded as chief director by Dr A Pizzi, previously assistant director and head of the Wood Chemistry Division.



Dr A Pizzi
Chief Director, National Timber
Research Institute, from 1984

COAL

The first colliery in South Africa came into operation in 1864 and thereafter the coal industry expanded steadily. By 1920 coal sales exceeded ten million metric tons, and by 1980 production was worth more than 100 million metric tons a year.

Under South Africa's first Coal Act (No. 27 of 1922) an effort was made to control coal exports and to ensure the maintenance of a minimum quality of export coal by establishing coal grading committees under the jurisdiction of industry.

In the late 1920s the accelerated development of the coal mining industry aroused interest in coal research, and a number of South African students were sent overseas for advanced study in this field. Among these were Dr F Meyer who studied at the Technische Hochschule in Berlin, and Dr P N

Lategan who studied at the Imperial College, London, and at the Fuel Research Station, Greenwich. On their return they took the lead in the development of fuel research in South Africa. A report by Dr Meyer to the Board of Trade and Industry was accepted by the Government, and his recommendations were embodied in the Fuel Research and Coal Act (No. 36 of 1930) which provided for a Fuel Research Board and a Fuel Research Institute.

The functions of the Fuel Research Board, comprising representatives from both the public and private sectors, were to formulate and control the institute's policy on broad and national lines, to control its finances, and to determine the nature and scope of research. The board appointed technical advisory committees to give guidance on the nature and scope of research and the planning and cost of pilot plants.

The first chairman of the board was Dr J S van der Lingen, who held office from 1930 to 1939. Succeeding chairmen were Dr S H Haughton (1940-49), Dr F J de Villiers (1949-58), Dr B Gaigher (1958-74), Dr A J Petrick (1974-77), Mr H R P A Kotzenberg (1977-78), Mr C F Scheepers (1978-80) and Dr J F Kemp (1980-83).

A point of interest is that Dr Haughton and Dr De Villiers were members of the first CSIR Council, Dr Gaigher was a member of the council from 1956 to 1975, and Dr Kemp, deputy president of the CSIR, was chairman from 1980 onwards.

A strange feature of the original organization was that the director of the institute attended meetings of the board by invitation only, and that the chairman of the board was effectively the chief executive officer of the institute. This anomaly was rectified during Dr Haughton's term of office as chairman of the board. In 1940 the board decided that the director should attend all meetings, and in 1948 the director became the chief executive officer, under the board, with full responsibility for all administrative and technical staff.

The first director, Dr T E W Schumann, who was appointed in 1931, found the position untenable and resigned after eighteen months. The directors for the ensuing period were Dr J C Vogel (1933-40), Dr F J Tromp (1941-46), Dr A J Petrick (1948-72), Dr C C la Grange (1973-78) and Dr T C Erasmus (from 1980).

Dr Petrick was the first to derive the full benefit of the improved status of chief executive officer. Under his leadership considerable headway was made in all spheres of coal research, and towards the end of his career he assumed the important post of chairman of the Commission of Inquiry into the Coal Resources of the Republic of South Africa – a body which eventually produced the well-known *Petrick Commission Report*. By 1975, when the commission had completed its report, Dr Petrick had retired and had been appointed chairman of the Fuel Research Board.

The institute operated as a national agency empowered by Parliament to investigate the fuel resources of the Republic and to test, analyse and grade coal products and to undertake research on all matters relating to fuels and fuel by-products to help the coal mining industry make the most of the



Dr A J Petrick
Director, Fuel Research Institute,
from 1948-1972.

country's primary fossil fuel asset. The institute was funded by a levy on coal sales matched by a sum voted by Parliament. This was supplemented by grants from the Government and other parties concerned. It was also authorized to undertake contract work.

When the Fuel Research Institute came into being in 1930 all technical and research work was carried out in laboratories of the University of Pretoria and the University of the Witwatersrand. A site in Lynnwood Road, Pretoria, opposite the University of Pretoria, was chosen for the building of the first complex and in 1933 the staff moved in. A few years later, the City Council of Pretoria made available a four-hectare site in Pretoria West for large-scale pilot plant operations to serve the growing research demands of a developing industry in a network of coal-oriented undertakings such as the Electricity Supply Commission (Escom), the South African Iron and Steel Industrial Corporation (IsCOR) and others.

To comply with the requirements of the Act and to meet the needs of industry, the research effort of the institute included the development of methods of cleaning and grading coal for the market, the establishment of criteria by which the liability of coal to spontaneous combustion might be estimated and the use of coal as raw material for producing coke, gas, liquid fuel and chemical products. These activities were organized into the Survey Division, the Engineering Division and the Chemistry Division.

From the outset one of the most important objects of the institute was to study and investigate the fuel resources of the country. A survey section concentrated on chemical and physical characteristics of the country's coal deposits. For this purpose it carried out its own analyses of prospecting borehole cores, samples of which were made available by coal prospectors. As a consequence its records came to be generally accepted as the most comprehensive and reliable available.

In the course of the institute's pioneering investigations, it soon became apparent that the petrographic composition of South African coals differed widely from those found in the northern hemisphere. Most of the techniques and experimental procedures used abroad had to be adapted to suit local conditions, and in many instances new expertise had to be developed to realize the potential of South Africa's 'problematic' coals. New knowledge gained from petrographic studies contributed to a better understanding of South African coals in relation to their technological behaviour and usefulness for specific applications, such as the carbonization industries.

Other achievements of the institute included:

- An improved understanding of spontaneous heating by means of a large-scale test to identify potentially dangerous coals.
- Pioneering work on coal beneficiation in the pilot plant.
- International recognition for the quality of analytical services; for example, from 1976 the institute prepared and analysed samples of all coal exported through Richards Bay and issued certificates of analysis. (This function was transferred to the South African Bureau of Standards in 1984.)

Characterization of South African coals

Safety in coal mining



Dr T C Erasmus
Chief Director, National Institute
for Coal Research, from 1984

The National Institute for Coal Research

The national experimental
fluidized-bed combustion plant at
Pretoria West.

- Beneficiation of 500x75 microns coal in the dense medium cyclone.
- Improved quality of coke produced from South African coal blends.

Following the Coalbrook Colliery disaster in 1960, a non-corporate body, the Coal Mining Research Controlling Council, under the chairmanship of the Government Mining Engineer, was established. For administrative purposes, including financial control, the council fell under the Fuel Research Board but otherwise functioned independently. The Act was amended to make provision for a special levy on coal (and an equivalent government contribution) to finance the activities of the council.

Research projects were contracted out by the council to institutions such as the Chamber of Mines Research Laboratories, the Fuel Research Institute and laboratories of the CSIR. The Fuel Research Institute's activities were concerned mainly with fire and gas hazards in coal mining and included studies on the emission of methane from coal and adjacent strata, the explosiveness of coal dust and the early detection of incipient underground fires.

The Fuel Research Institute operated as an autonomous organization under the control of the Fuel Research Board until January 1980 when its functions were entrusted to the CSIR. The institute was officially incorporated into the CSIR in April 1984 and was renamed the National Institute for Coal Research (NICR) with Dr T C Erasmus as chief director.

A milestone in the development of the NICR and its role in providing assistance to industry was the erection of a national fluidized-bed combustion plant. The Department of Mineral and Energy Affairs allocated R2,5 million towards this facility, which was formally inaugurated on 27 May 1985. This was an important step towards using that part of South Africa's



mined coal which would otherwise go to waste. With this technology, coal too fine for combustion in conventional commercial boilers could be used, and also coal with a high ash content could be fired. As the accumulated high-ash coal amounted to 35 million tons and the accumulated small coal to 3 million tons in 1984, this represented a loss to the mining industry in excess of R200 million. In addition, this fluidized-bed technology held out the possibility of effecting sulphur capture through the addition of a suitable sorbent.

Construction and Transport

BUILDING RESEARCH

In 1945 when Dr Schonland, as scientific adviser to the Prime Minister, was planning the CSIR he had the benefit of the advice of Mr E W Dohse, chief engineer of the Public Works Department, who was seconded to the Department of Commerce and Industry to assist him in organizing building research under the proposed national research council. Dohse visited research organizations in Britain and America to study the most recent trends in this field, and on his return served as acting director of the National Building Research Institute (NBRI), set up by the newly established CSIR.

In January 1947 Mr J E B (Jere) Jennings, who had been head of the Engineering Division of the NBRI since April 1946, took over as acting director and as director in August. With his special interest in soil mechanics, a field in which he had obtained an MSc degree at the Massachusetts Institute of Technology in Boston, he retained personal responsibility for the institute's Soil Mechanics and Foundation Engineering Division which pioneered the application of scientific soil mechanics principles in South Africa. Jennings held this post with great distinction until he left to become professor and head of the Department of Civil Engineering at the University of the Witwatersrand in 1955.

Dr N Stutterheim, a chemical engineer, succeeded Jennings as director. He had joined the institute when it was first established, as head of its Materials Division. His work in the field of cement chemistry, particularly in the production of cement from blast furnace slag with a high magnesia content, and his later work on shrinking aggregates won international recognition. Not only did his work on slag contribute to the solution of a waste disposal problem but it also led to the establishment of a new industry in South Africa. 'Since the middle 1950s all large concrete dams in South Africa such as the Josini, the Hendrik Verwoerd, the P K le Roux and hundreds of other major concrete structures have been built with this high magnesia slag cement.* In 1959, when Dr Stutterheim was appointed a vice-president of the CSIR, Dr T L Webb became director. Dr Webb who had joined the institute in 1947 and followed Dr Stutterheim as head of the Materials Division, was well-known for his work on differential thermal analysis.



Mr J E B Jennings
Director, National Building
Research Institute, 1947-1955



Dr N Stutterheim
Director, National Building
Research Institute, 1955-1959

Optima, October 1986, pp.136-139.



The National Building Research Institute, the first major laboratory building, occupied in 1954.



Dr T L Webb
Director, National Building
Research Institute, 1959-1980

Whereas in its earlier developing years the work of the NBRI might have been described as applied science in a number of building-related technological fields, under Dr Webb it evolved, in response to the needs of the industry and the country, into an industrially orientated organization involved in all aspects of building and construction technology.

In September 1980 Webb, after some 20 years as director, retired and was succeeded by Mr J F van Straaten, a former head of the Environmental Engineering Division, who had established an international reputation as an authority on the thermal performance of buildings. Dr J Morris, previously head of the Organic Materials Division, and later Counsellor (Science and Technology) in London, became chief director of the NBRI in 1984.

The building industry, as old as civilization and steeped in tradition, was, and, to a large extent, still is, made up of a large number of separate small firms, independent in character with relatively limited capital resources. Such a situation militated against progressive research and organized attempts at applying modern scientific methods. Such research as had been undertaken in this country relating mostly to the construction industries had been individual and unco-ordinated. The generally prevailing view among architects, engineers and builders was in fact that the scope for research in the building industry was limited. These were some of the considerations which had weighed with the CSIR in deciding to establish a national institute, financed largely by State funds, rather than a co-operative research association to be financed by the industry.

Against this background, therefore, it was natural for the NBRI to concentrate its first efforts on problems seen to be of national interest. The most obvious and urgent of these was the provision of low-cost urban housing, identified as a priority by the Building Research Advisory Committee, first set up in 1945 by the Department of Commerce and Industry under the chairmanship of Mr Dohse and then taken over by the CSIR.

The problem was first defined in terms of the number of houses required – indicated by surveys to be 35 000 a year over the following 10 years, which implied speeding up the rate of building by as much as four times. To achieve this target at the rate of funding which was considered to be feasible by the State, it was imperative that the cost per housing unit should be



Mr J F van Straaten
Director, National Building
Research Institute, from 1980
(Chief Director 1983-1984)

*Low-cost urban
housing*

reduced drastically. To meet this challenge, a programme was drawn up involving all the divisions of the institute, including architecture, functional efficiency (heating, cooling, ventilation, lighting, comfort, etc.) and engineering. According to Jennings, most of the other 20 projects of these divisions also had a bearing on the solution of this problem.

To provide minimum standards of accommodation for acceptable living conditions, design criteria were drawn up based on surveys undertaken by some 150 voluntary workers serving on subcommittees, covering all aspects of the living patterns of the lower income groups in South Africa. These criteria were extended to include estimates of the expected development over the next 40 years.

The final result was a series of criteria which the National Housing and Planning Commission used in drawing up a series of type plans, showing how they could be applied to families of different sizes. An undertaking was also given that the type plans would not be changed for at least three years, which gave specialized builders an opportunity to equip themselves to build such houses with the assurance that their equipment and procedures would remain useful for at least this period. The type plans were not standards in themselves – any building authority could develop its own plans within the framework of these minimum standards of accommodation. The trend was, however, for the type plans to be used for State-assisted low-income housing.

The next step was to ascertain the rent-paying capacity of urban black populations. Surveys indicated that the people requiring housing fell into four groups: those who were very poor and needed the greatest assistance, those who needed some assistance, those who could just manage and those who could afford something better. In the belief that the economics of housing starts with township layout, the institute took these differences into account in the planning of several full-scale experimental township development projects. The most noteworthy was the township of Kwa-Thema at Springs, where the proportions of the four groups mentioned were found to be 47, 14, 23, and 16 per cent respectively, similar to the situation in most areas. The layout of Kwa-Thema provided for a density of 10 single-storey dwelling units an acre, which was considerably greater than had hitherto been adopted. Houses of different type plans for the four income categories were grouped in a manner intended to avoid the monotony of total uniformity so as not to stifle the ambitions of the more well-to-do or force people who could afford very little into accommodation beyond their means.

To determine the cheapest and most effective form of construction, foundations, floors, walls and roofing and their costs were studied individually in the light of the minimum performance requirements. To overcome the shortage of skilled workers, a scheme for the use of semiskilled workers was proposed. The various tasks performed in building a house were broken down in terms of the skills required:

- The setting out of the house and setting up of door frames and windows – the highest skilled workers.
- The erection of corners – less skilled workers.
- Infilling work between pre-erected corners – least skilled workers.



Dr J Morris
Appointed Chief Director, National
Building Research Institute, in 1984

*'Operator building'
scheme*

This scheme of 'operator building', used on reasonable-sized schemes in which there was a fair degree of repetition, had many advantages, the most important of which was that only a small percentage of highly skilled workers was required. The building of 50 experimental houses and later the full-scale building of about 200 by an independent authority demonstrated that the operative scheme was practical and could produce work of a good standard. The success of this research played a key role in the subsequent provision of over 500 000 houses for urban blacks, thus providing large-scale relief. Because these procedures made it possible to provide permanent housing at the lowest cost yet devised anywhere in the world, they found application in many other countries, and particularly in Africa where the NBRI played a leading role in the work of the Commission for Technical Co-operation and Scientific Council for Africa South of the Sahara (CCTA/CSA).

This outstanding success can be attributed to the inspired but balanced leadership of Jennings. In his own words: 'While keeping the human picture always before our minds we must be prepared to delve deeply into all the details needed for our solution, but never allow enthusiasm for any one particular detail to make us lose sight of the broad objective of service to man. In this pursuit we are going to find the team of sociologists, architects, engineers, psychologists, physiologists, quantity surveyors, lawyers, chemists, physicists, builders, craftsmen and administrators, each contributing to a whole engineering solution.'

These were valuable contributions to the alleviation of a problem for which there is no final solution because of the changing patterns of urbanization in a rapidly developing economy with changing social circumstances. In the long term, the most valuable contribution must be seen as the general

The clean operating enclosure developed by the NBRI in collaboration with the Transvaal Department of Hospital Services at the H F Verwoerd Hospital. The plastic side curtains have been raised to give a better view of the enclosure.





Part of the KaNyamazane demonstration project near Nelspruit, incorporating an innovative lay-out, alternative house-types designed and sited in such a way as to facilitate easy expansion and improvement.

adoption of an approach evolved through research for a technology aimed at meeting social needs. This approach provided the basis of a continuing programme of research, not only into housing but also in school and hospital design and development. Much of this work found application in a large number of buildings for educational and health care purposes.

In the 1970s a new research and development framework for low-cost housing for blacks in South Africa was established by the NBRI in collaboration with the Department of Co-operation and Development. A feature of this arrangement was that it created opportunities for testing new ideas, concepts and hypotheses by practical application in pilot development projects before implementation on a wider scale. Universities throughout the country were visited to see how they might collaborate in this programme. The aim of one of these projects was to investigate the means by which the private sector could supplement the Government's housing schemes. This included the production of a series of designs for different types of house in keeping with the layout of the town and its facilities and the involvement of the community in the planning of projects. One of the features of a demonstration project at KaNyamazane, in the Nelspruit district, was the arrangement of houses around open spaces of various shapes and sizes, connected directly to service roads. With this layout, more houses could be built in a given area and, because access roads were reduced by 20 per cent, both capital and maintenance costs, for example, for engineering services, were also reduced. In co-operation with the local authority, a series of alternative basic dwelling types were designed, familiar construction methods were applied, and locally produced building materials were used, thereby stimulating the local building industry, private entrepreneurs and the do-it-yourself approach.

In another application project, the institute investigated housing in the black residential area of Graaff-Reinet. Its recommendation that the residential area should be retained and gradually upgraded in keeping with the financial ability of the community was accepted and applied through a co-ordinating project committee representative of the Department of Co-operation and Development, the Department of Community Development, the Department of Education and Training, the Graaff-Reinet Municipality, the Divisional Council and the National Building Research Institute. The

*Foundation
engineering*

conclusions from this, the first project of its kind to be undertaken by the Government, were not only that upgrading or improvement programmes must include guidelines designed for the short, medium and long term, but that it was advisable to accept, with community participation, lower but acceptable building standards which could be upgraded gradually.

Although research into low-cost high-density urban housing was a major commitment, the NBRI was, from the outset, engaged in research on the basic aspects of building and construction such as soil mechanics, materials, engineering and the functional efficiency of buildings. All this research was related to circumstances peculiar to South Africa.

In the field of soil mechanics, the identification of expansive clays as a cause of disastrous foundation problems encountered in buildings and other structures was one of the most significant contributions of the institute. The mechanism of swelling and swelling pressures was elucidated, the mineral constituents of clays responsible for this phenomenon were identified, and a range of alternative economic and practical measures for overcoming the problem were developed. This work also received international recognition. Other contributions in the field of soil mechanics were made in the study of the stability of slimes dams for the gold mining industry and the disposal of ash on behalf of Sasol and Escom.

Building materials

Outstanding contributions in materials research which saved the country many millions of rands included:

- The development of a method of making a satisfactory slag cement from steelworks slag with a high magnesia content.
- The development of a method of producing satisfactory building lime from dolomitic limestone ('blue lime').

A plant producing slag cement from steelworks slag with a high magnesia content.



- Solving the problem of deterioration of concrete sewer pipes caused by attack on the concrete by sulphuric acid produced by sulphur oxidizing bacteria. This was achieved through the apparently simple but highly innovative expedient of using calcareous aggregates to neutralize the acid, and also by improving the design of sewers.
- The development of very durable roof paints for application to new galvanized steel sheets.

Engineering research focused on concrete structures and included aspects such as prestressed concrete construction, the problem of excessive dimensional change in concrete caused by unstable aggregates, corrosion of steel reinforcement, and non-destructive methods of testing concrete. Through this work the institute won widespread recognition as a centre for expertise in concrete technology and in 1974 the South African Railways commissioned it to investigate concrete cores from the Pirow Street Bridge in Cape Town. The project was extended to a systematic investigation of concrete structures in the western Cape which revealed that the deterioration was both extensive and serious; about 50 per cent of all exposed concrete structures were affected, the percentage being higher for more recent structures. The deterioration was found to be due to expansion of the concrete as a result of a chemical reaction between the alkalis in the cement and the coarse aggregates commonly used in the region. Various public and private bodies contributed to an intensive research programme in which the NBRI developed rapid methods of identifying reactive aggregates and found ways of overcoming the problem.

Another investigation carried out in collaboration with industry, concerned the development of large concrete tanks for the bulk storage of crude oil. As there was little information available on this subject, a programme of research was initiated by the NBRI to address issues such as the permeability of concrete to crude oil, the effects of oil on concrete, the control of cracking in the concrete by means of reinforcement or other measures, and the evaluation of various coatings and lining materials. These are but two examples to indicate the role of the NBRI as a centre of expertise in the field of concrete technology.

The eventual aim of all building research is to provide at lowest cost durable structures which are best suited to the purpose for which they are intended. To achieve this a great deal of fundamental research went into the functional efficiency of buildings, embracing aspects such as heat flow through building elements, building climatology in relation to ventilation, the heating and cooling of interiors, ceiling and wall insulation, interior lighting and solar water heating. Other activities extended to the study of wind forces on buildings, fire research, hail resistance of roof materials (for which a compressed-air device was designed for firing artificial hailstones at material under test at controlled and measured velocity) and sewerage and sanitation, with special reference to the disposal of liquid effluent in small communities.

A project of significance to South African manufacturing industry in general was highlighted in 1976 when the Minister of Manpower inaugurated a series of studies employing a mobile climate laboratory, designed and

Concrete technology

Functional efficiency of buildings

This mobile climate laboratory was used on the factory site to measure the effect of indoor environmental stresses on the productivity of workers.



constructed by the NBRI with the assistance of a research consultant from Sweden. This project, undertaken by the institute and sponsored by the Department of Manpower, was concerned with measuring the effect of moderate indoor environmental stress, such as temperature, humidity and ventilation, on the productivity of factory workers. The mobile climate laboratory was taken to factories throughout the country so that the reactions of workers could be studied close to their own working environments. It was envisaged that the information gained from these studies could be used in bringing the South African Factories Act up to date, thereby leading to better working conditions for factory workers not only in South Africa but also in other countries with comparable climates. For example, it was found that, although test subjects had predictable comfort preferences, i.e. in the temperature range from 20 °C to 24 °C, their productivity peaked at around 32 °C. In the climatic circumstances in which these tests were conducted, there was therefore little advantage, from a productivity point of view, in cooling factories artificially as acceptable working conditions could be achieved by straightforward building design procedures.

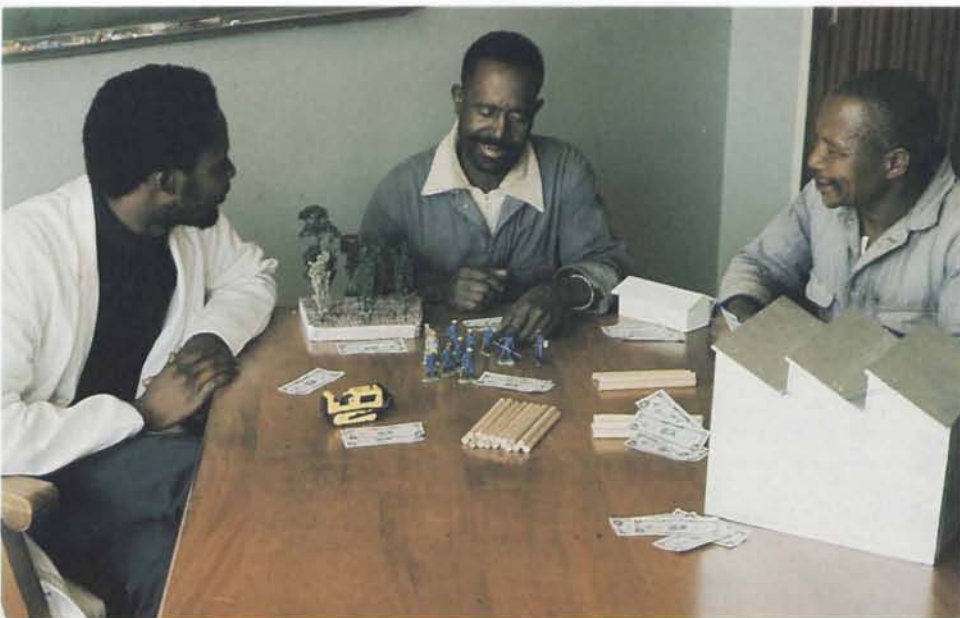
In 1980 a new Division for Energy in Buildings was created to concentrate research on the best use of energy in buildings, such as the design of new buildings to use the minimum energy, the saving of energy in existing buildings, and the use of solar energy for water and space heating, including full-scale demonstration projects.

By 1985 the NBRI was further involved in investigations into the design of buildings and services, structural and foundation engineering, acoustics, lighting, ventilation, thermal performance, the behaviour and development of building materials, and the management, organization and industrialization of the building process.

The institute had come a long way since March 1947 when, with an annual budget of R89 200 and a staff of 24, it had a research programme of 21 major projects. By 1970, the budget had increased to R1,4 million and by 1980 to R4,8 million with a staff of some 240. The budgets for those years, however, represented only about 0,1 per cent of the amount spent on building and construction in South Africa. The institute derived about 60 per cent of its



The Heavy Vehicle Simulator developed by the National Institute for Transport and Road Research.



Designed by the National Institute for Personnel Research, the 6M Simulation course provides insight into basic business concepts.

A numerically controlled profile cutting machine in the plate metal workshops of the Technical Services Department.



A low-cost automation system for manufacturing lipstick cartridges, developed in the Technical Services Department for a South African industry.



income from a direct parliamentary grant and the remaining 40 per cent from sponsored research projects and related investigations and services undertaken on behalf of central, provincial and local government, the private sector and individuals with particular building problems. Each year the institute dealt with some 25 000 queries and received approximately 6 000 formal visitors of whom about 10 per cent were from foreign countries.

In the 1960s and 1970s the NBRI did effective work in Zimbabwe, Malawi and other states and set up regional offices in Cape Town, Windhoek, Durban, Port Elizabeth and Bloemfontein. In addition to maintaining contact with its overseas counterparts, the institute participated in the activities of non-governmental international bodies, notably the International Council for Building Research Studies and Documentation and the International Union of Testing and Research Laboratories for Materials and Structures.

In addition, it played a leading role in the formation and operation of the informal group of directors of English Speaking Building Research Directors. Through meetings held every three years or so, over a period of 30 years, this happy association provided a valuable forum for the exchange of information on a person-to-person basis. The NBRI also arranged four well-attended international building research congresses in Johannesburg, Pretoria, Cape Town and Durban.

The institute also initiated the setting up of the Building and Construction Advisory Council; it provided the secretariat of the Committee on the Use of Computers in the Building and Construction Industry, and operated a Construction Industry Computer Information Centre, the functions of which included surveys of the availability of computer programs in use in various fields, such as civil engineering, and research into the computerization of various activities in these fields.

From its inception the NBRI had been much concerned about the effect of outmoded regulations that inhibited innovations in the building industry, particularly in the use of new building methods and new materials such as plastics. Therefore, when the demand arose for the technical evaluation of building innovations, particularly those concerned with building systems, the NBRI, working through the Building Industry Advisory Council, played a leading role in setting up and operating the Agrément Board of South Africa as far back as 1969 with the NBRI as its evaluating agency, and subsequently as a technical advisory body. By 1985 the Agrément Board had investigated and issued agrément certificates for 174 innovations.

In accordance with the recommendations of the report of the Commission of Inquiry into Housing Matters (the Fouché Commission), the NBRI was requested in 1979 by the Secretary for Community Development to investigate housing costs, to formulate rational norms for urban services such as water supply, sewerage, drainage, electrical reticulation and roads, and to prepare a manual covering these services. From 1983 this manual was used to an increasing extent by local authorities throughout the country.

In this evolving pattern of development, the institute's Building Research Advisory Committee, first set up in 1945, had over some 40 years played not only an indispensable role in achieving the sustained co-operation and

National and international co-operation

Agrément Board of South Africa

The post of director of the unit was advertised internationally and offered to Dr P J Rigden, who had been interviewed by Dr Schonland in London in June. This proved to be a fortunate appointment as Rigden had worked for more than 10 years under Dr Lee and Dr Glanville at the British Road Research Laboratory which since 1936 had led the world in the technique and underlying philosophy of properly designed and controlled full-scale road experiments. Thus, when he arrived in South Africa on 2 January 1951 to start the Bituminous Binder Research Unit, he brought with him first-hand knowledge of the British experience in road research. Within a year an elaborate road surfacing experiment was conducted on the old Pretoria-Johannesburg national road, and another on a nearby provincial road. Subsequently road experiments were conducted in all four provinces and, much later, in Ovamboland in South West Africa.

From the outset the unit faced problems in finding adequate accommodation. After five months in one office and a small laboratory at the Fuel Research Institute in Lynnwood Road, an old house in Struben Street, which was adapted and subsequently extended by the owner, was rented for the unit.

The unit's terms of reference confined its activities to studying the performance of locally produced road binders, namely coke-oven tars and shale-oil bitumen. However, on 19 August 1953 Colonel McLaren proposed to that Steering Committee that the scope of the research be widened. He said there was a pressing need for research on road foundation design, gravel roads and low-cost roads generally. He envisaged an expanded unit that would eventually become a national institute of the CSIR. The proposal followed on extensive discussions with Mr L C Reynolds, deputy chief engineer of the Department of Transport who, impressed with the approach of the new unit to surfacing problems, saw a role for the CSIR in foundations research and particularly gravel roads, which at that time still provided a large proportion of rural main road mileage, including some national roads.

One of the members of a committee appointed to examine Colonel McLaren's proposal disagreed on the grounds that research should be the responsibility of the Government and provincial roads departments. However, the other members recommended that the CSIR should appoint an action committee to examine the proposal in more detail. At a meeting in February 1954 the council accepted the recommendations and appointed an action committee consisting of representatives of the CSIR, Iscor, Transvaal Roads Department, Department of Transport and the University of Stellenbosch. The chairman was Mr E W Dohse.

When the committee started work in 1954, its first task was to define the problems needing attention and to draw up a roads research programme. Meanwhile, Mr Reynolds, by then chief engineer in the Department of Transport, submitted a memorandum to the National Transport Commission in which he emphasized the need for unbiased, objective road research in South Africa which, he considered, could be done only by the CSIR. He urged the commission to make funds available from the National Road Fund for the work. Referring to the CSIR's facilities, he said that 'a start has been made along these lines with the establishment of the Bituminous



Dr P J Rigden
Appointed Director, Bituminous
Binder Research Unit, in 1951;
Director, National Institute for
Road Research, 1955-1970

Binder Research Unit which has proved to be far more suitable than any organization the provinces or the National Road Board were able to establish.'

The significance of this was that within three and a half years of its creation, the unit had proved to hard-headed road engineers the value of a scientific research approach to their problems and had created an atmosphere where it was possible to promote, and have accepted, the idea of a broadly based road research organization.

The commission reacted quickly to this proposal from its chief engineer and in November 1954 the Secretary for Transport asked the CSIR whether it would be prepared to set up an organization, incorporating the unit, to undertake road and traffic research. The commission offered to contribute £15 000 a year towards the cost in the initial period. The CSIR Council in February 1955 agreed in principle to the establishment of a National Road Research Institute, financed jointly by the CSIR, the Department of Transport, the Provincial Administrations and possibly the municipalities.

This was approved by the Minister of Economic Affairs (at that time the Minister responsible for the CSIR), subject to the condition that the CSIR would not have to bear any additional cost. In view of this qualified approval, Dr Naudé insisted that the establishment of the institute could not go ahead until some authority was prepared to guarantee the minimum funds required for an indefinite period. He therefore asked the Secretary for Transport for a guaranteed maximum of £60 000 a year from the National Transport Commission to fund the new institute. On June 16 Dr Naudé was informed that the commission had agreed to his request on condition that funds were not used to acquire fixed assets such as land and buildings. In the meantime the Transvaal Province offered to contribute £3 000, £10 000 and £15 000 for the first three years respectively. Natal also guaranteed a contribution.

National Institute for Road Research

The way was now open for the CSIR to announce the creation of a National Institute for Road Research (NIRR) which came into being in September 1955 with Dr Rigden as its director. The minimum funds required to run the institute were guaranteed by the Department of Transport which undertook to recover 30 per cent of the amount from the four provincial administrations (Transvaal 11 per cent, Cape 11 per cent, Natal five per cent and the Orange Free State three per cent), the balance coming from the National Transport Commission. The annual budgeting procedure of the institute was somewhat cumbersome, as consensus between the four provinces and the department had to be reached every year on all proposed research projects before they could be included in the total roads budget of the National Transport Commission for approval by the Minister of Transport. Although somewhat protracted and time-consuming for the institute, this arrangement did have the merit of ensuring close co-operation with the road authorities.

The Bituminous Binder Research Unit was incorporated in the new institute and became the Bituminous Materials Division, but for the time being it continued to be financed as before. Funds available for its running expenses, guaranteed by the sponsors for a five-year period, were increased to nearly

R26 000 a year in 1954. Additional financial support was secured from the oil companies and the bitumen emulsion producers.

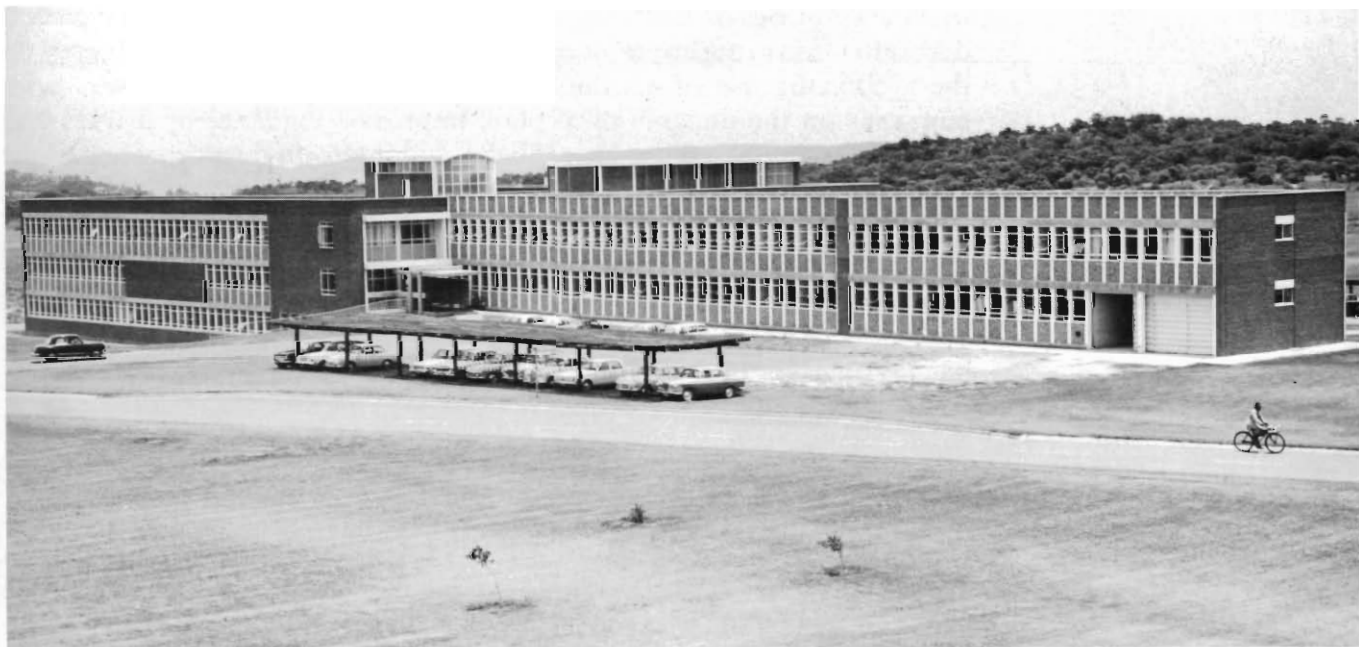
It was envisaged that the Institute's research, in addition to materials, road design, construction and maintenance, would include road economics and road safety. The broad programme developed by the unit, embracing both the fundamental problems of binder durability and the practical problems of the use of binders for road surfacing, would be expanded.

With the creation of the Institute for Road Research, provision was made for the accommodation of additional staff. Arrangements were made for staff engaged in research on road foundations and soil properties to work initially in the Soil Mechanics Division of the NBRI. This had the advantage of avoiding duplication of specialized staff and expensive equipment. A new Special Problems Division was housed in a prefabricated building on the NBRI test site at Scientia. The headquarters of the Institute and the former Bituminous Binder Research Unit moved in 1958 to Visagie Street to space vacated by the CSIR's Executive and Administrative Services Department when they moved to Scientia.

It was not until 1963, however, that all the sections of the institute were brought together under one roof in a new building at Scientia. All the senior engineers of the national and provincial roads departments were present when the building was formally opened by the Minister of Transport, Mr Ben Schoeman, in February 1964.

By this time the institute had gained the confidence of the road authorities and engineers by helping them to define their road problems in terms amenable to solution by research, stressing the need for full-scale road experiments and tests on the road, and by assisting them in investigating

The building of the National Institute for Road Research at Scientia.





Dr S H Kühn
Director, National Institute for
Road Research (became National
Institute for Transport and Road
Research in 1976), from 1970
(Chief Director from 1983)

Road safety

failures and other problems on their roads. From the outset Rigden continually reminded the road authorities that the institute, although part of the CSIR, was their institute and in effect their 'research arm'. In a paper presented to the first biennial conference of the Australian Road Research Board in Canberra in 1962 he put forward the view that research and practice shared the same objective, namely to build better roads at minimum cost. Therefore, while road engineers must see to it that research is aimed in the right direction and that its results are applied in practice, research staff must assist the roads engineer with whatever problems he encounters in road building and maintenance. This implied a consulting role for the Institute in addition to its research role, and Rigden was convinced that without this function, the institute could not serve the road authorities effectively.

In 1970 Rigden was appointed a vice-president of the CSIR and Dr S H Kühn, one of the first staff members of the Bituminous Binder Research Unit, became the new director of the institute.

Road safety research was included in the terms of reference of the institute when it was established in 1955. A start was made with the appointment of two staff members but by 1960 it was evident that a much bigger effort was required. However, difficulties were encountered in obtaining the necessary funds. The policy of the existing National Road Safety Organization, which operated under the auspices of the Department of Transport, was to allocate its limited research funds to individuals at the universities – a practice which in no way contributed to a co-ordinated road safety research effort. Nevertheless, by 1965 the institute was spending 20 per cent of its total budget of R520 000 on traffic and accident research of which the then Road Safety Council's contribution was a mere R15 000.

Starting with surveys of road accident data in the larger cities, enough had been done by 1970 for the institute to publish a report summarizing the information gleaned from research and accident analysis at the institute and in other countries on methods of reducing road accidents. This publication drew attention to the importance of programmes to improve roads based on the systematic use of accident data, education of all road users with emphasis on the dangers of alcohol, improved vigilance of drivers and pedestrians, increased use of seat belts, and intensified enforcement of the law in respect of excessive speed and driving under the influence of alcohol.

In the early 1970s the road accident problem was very much in the public eye and a commission of enquiry was appointed, chaired by Dr Dirk Steyn (retired chairman of the Public Service Commission), to investigate the matter. The main recommendation of the commission, before which the institute had given evidence, was that a small, high-level National Road Safety Council should be created by Act of Parliament, with adequate funding to tackle the road accident problem. In the Draft Bill (1972) the CSIR was named as a body to be involved in a research programme financed by the proposed new council. However, Dr Rigden, by that time a vice-president of the CSIR, was not satisfied that the proposed body would be in a position to ensure the effective application of the results of professional and scientific research on road safety. As a result of his vigorous represen-

tations to the Secretary of Transport, he himself was appointed chairman of the council, a post he held for eight years.

At this time there was a growing concern over transportation problems in the urban areas. These were investigated by the Driessen Committee into Urban Transport Facilities. Its report, published in 1975, recommended that all aspects of urban transport research, including transport planning, traffic control, public transport and transportation information, should be undertaken by the institute with additional funding by the Treasury through the National Transport Commission and that the institute be renamed to reflect the broadened scope of its activities. These recommendations were supported by the CSIR and approved by the Government in 1976.

The institute, renamed the National Institute for Transport and Road Research (NITRR), was subsequently reorganized into three main branches – the Roads Branch concerned with the design, construction and maintenance of roads, pavement engineering, pavement management, soil engineering and road bridges; the Safety Branch concerned with accident analysis, safety engineering, the road user and the vehicle; and the new Transportation Branch concerned with transport analysis and marketing, operations, planning, rural transport and traffic engineering.

To provide for the expanded research activities of the Safety and Transportation Branches, the institute's building was enlarged by the CSIR in 1977 with the addition of a third wing, thereby increasing the floor area by 30 per cent.

A Transport Information Bureau was set up as an agency of the Department of Transport in December 1982. It consisted of the Vehicle Data Bureau, which had been started in 1981, and the Central Road Traffic Bureau (operated by the CSIR on behalf of the Department of Transport) which were jointly responsible for the collection and recording of data in the following registers:

- A central vehicle ownership register.
- A central driver's licence register.
- A central traffic and transport offences register.
- A central accident register.
- Such other registers as the Minister of Transport Affairs might approve.

Parallel with the development of the above registers, the Transport Information Bureau, in collaboration with the National Road Safety Council, investigated the need for the extension of these facilities to various independent States in southern Africa. This led to the establishment of the International Road Traffic Bureau in 1984.

From 1972 onwards, test services on behalf of the road authorities to provide the information they needed for the planning of roads and the management of pavement maintenance were significantly expanded. In 1975 the institute also started providing contract services for these authorities; for example, investigations with two heavy vehicle simulators were carried out under contract to the Transvaal Provincial Administration and the Department of

*National Institute for
Transport and Road
Research*

*Transport Information
Bureau*

*Pavement design and
maintenance*

The heavy vehicle simulator developed by the National Institute for Transport and Road Research.



Transport. However, improvements in road design, construction and maintenance, as well as the more effective use of materials resulting from contract work done for individual authorities, were shared by all.

These contracts involved specialist investigation of unique problems and were often carried out not only in collaboration with road authorities but also with consulting firms. Interaction with civil engineering practice was furthered with the establishment of the Civil Engineering Advisory Council in 1975 on behalf of which the institute undertook investigations on aspects such as the use of appropriate technology in civil engineering construction, quality management, the balance of work between the public and private sectors, and the income of engineers.

Funds for research

Financing of research at the institute was, until 1971, on a year to year basis which made forward planning difficult. In 1971 the road authorities, which contributed the bulk of research funds, were approached to establish a more rational basis of funding. A funding package to be reviewed every three years was approved by the National Transport Commission in April 1972. It made provision for funding from the National Road Fund for normal cost escalation, statutory salary increases and the expansion of research. The provinces agreed to contribute on a proportional basis. Provision was also made for the establishment of a stabilization fund to provide for over or under-spending. These arrangements were of great help to the institute in its systematic planning.

With the establishment of the National Road Safety Council in 1972 an additional source of funding for safety research became available and funds were provided for research on human factors and systems information. This, together with the financing by the National Transport Commission of research into the engineering aspects of safety, provided a sound basis for progress.

When the Transportation Branch was established in 1976, funds for research on urban transportation were provided by the Treasury through the Urban Transport Fund, while additional money for research on rural transport was provided from the National Road Fund. These funds were annually adjusted to provide a modest but steady growth in this research.

The institute's staff increased from 124 in 1970 to 328 in 1985, an average annual growth of 6,7 per cent. During the same period research funds increased from a budget of R0,77 million to R14,3 million, an average increase of 23,6 per cent a year at ruling prices or 8,7 per cent in real terms at 1970 prices.

With its expanded scope, the institute set itself the task of providing solutions to the problems experienced by national, provincial and local authorities, suppliers, consultants and contractors in financing, planning, designing, building, maintaining and operating transport systems, including roads, to carry people and goods conveniently and safely. Cost, energy, climate and environmental factors were also taken into account. The institute's contribution can be illustrated by reviewing some of its major research achievements and other activities.

Research on roads

- Measures to improve the design, construction, maintenance and rehabilitation of road pavements were hampered because designs had to be evaluated from actual traffic – a method that was not only time-consuming but was influenced by varying traffic and environmental conditions. These difficulties were largely overcome by the development and application of the heavy vehicle simulator, which provided a powerful tool for evaluation of pavement designs based on sound theoretical approaches.
- Evaluation of different designs, backed by materials characterization in the laboratory, led to vastly improved performance and associated economic benefits. Methods investigated and subsequently documented in guidelines and accepted in practice included the use of cement-stabilized materials, crusher run, both bitumen and tar bases, and the reintroduction of water-bound macadam.
- Similar work of equal importance was carried out on bituminous surfacings which resulted in improved design and construction procedures for dense and gap-graded modifications of BS594 and open-graded porous surfacings.
- The blending of a 1,5 per cent admixture of polyvinyl chloride (PVC) with coke-oven tar yielded a binder for use in road construction which is economically competitive with bitumen, thereby achieving one of the original objectives of the Bituminous Binder Research Unit.
- A system of stabilizing sand was developed to provide a satisfactory road base material in regions of northern South West Africa which are overblown by Kalahari sand to depths of several hundred feet and where suitable aggregates for road-base construction are scarce and seldom

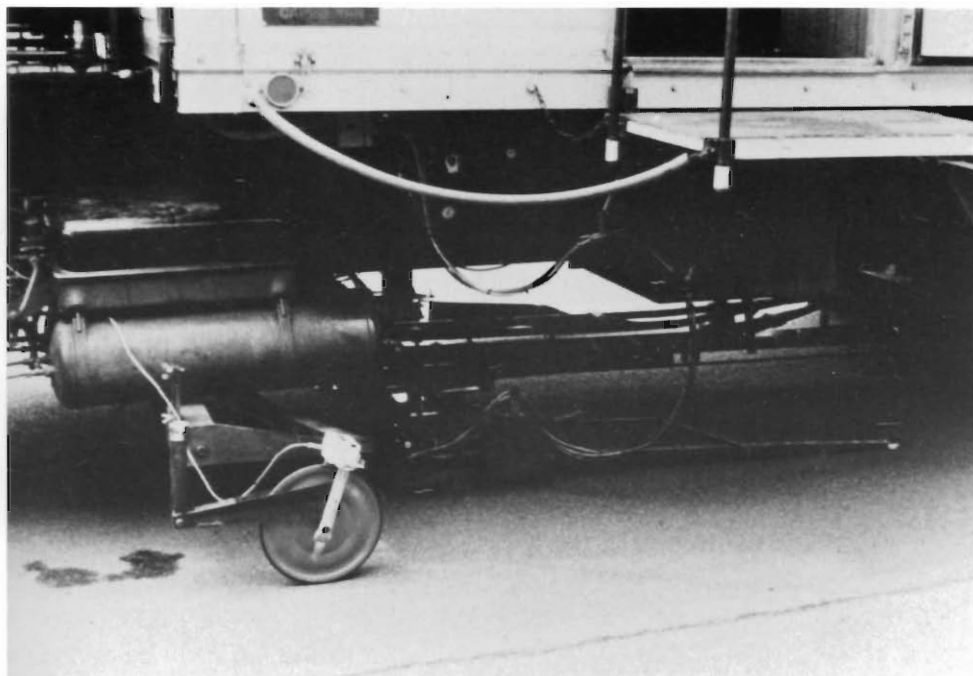
within economical hauling distance. This project included research into the use of calcretes and other local materials in road construction.

- A better understanding and quantification of the effect of wheel loading on the performance of road structures also benefited from investigations with the heavy vehicle simulator. This led to the definition of the relative influence of varying wheel loads on roads as well as wheel load damage to pavement structures. Information on the latter led to the better control of overloaded vehicles on roads with significant economic benefits.
- Methods for the maintenance and rehabilitation of roads also benefited from this work and these procedures are now used by rural and urban road authorities for the monitoring of road and pavement conditions and for taking appropriate action to ensure optimum performance and economic benefits.
- Another research development of both practical and economic significance was the establishment of guidelines for rational quality control and management of civil engineering works.

Instrumentation

Research on the design, building and maintenance of roads involving both field and laboratory experiments posed a requirement for instruments to measure and record the performance of road structures. As the instruments required were not commercially available, the institute took the lead in developing equipment needed for road-building and testing operations. For example:

- The heavy vehicle simulator, designed and constructed in collaboration with a commercial firm, experimentally accelerates the process of road disintegration so that a pavement's lifetime wear under traffic can be simulated in about 10 weeks. This equipment made a most important contribution to pavement and surfacings research in this country and attracted world-wide interest.
- Over a period of nearly 15 years the institute continued to develop and improve equipment for axle weight recording, vehicle classification, speed, and other factors, all under moving traffic. In 1985 this work resulted in a fully computerized traffic recorder and analyser. The equipment was manufactured and marketed by a South African firm.
- Various pieces of equipment were developed to measure road surface properties, including the modified PCA roadmeter, rut depth meter and a crack activity meter.
- Substantial improvements were made to a square-sided roller originally devised for soil compaction by Mr A R Berrangé. The most important of these advances was a mechanism for smoothing the fluctuating drawbar pull between tractor and roller.
- Equipment developed, manufactured and extensively used in measuring the properties of road and soil layers include the hidrodensimeter and short-range seismic instruments.



The La Croix deflectograph for continuous measurement of the surface deflection of pavements.

- Extensive modifications and improvements were made to the La Croix deflectograph, a road machine for continuously measuring the surface deflection of road and airport structures under a standard wheel load. As a result, a locally constructed machine was commissioned.

Road safety research

Up to 1972 road safety research was focused mainly on engineering problems and the identification of factors contributing to accidents. After 1972, with the increased financial support of the National Road Safety Council, this research was expanded into other areas such as law enforcement, the behaviour of road users, the effects of alcohol and drugs, vehicle safety, road traffic signs, post-accident emergency services, licensing procedures, the standardization of practical driving tests for drivers, and the use of seat belts. The road safety system and the establishment of driver assistance systems on freeways, such as the SOS patrol between Johannesburg and Pretoria and the emergency telephone system in the Cape Province, were also analysed.

The following are some examples of the institute's ongoing research and its application in practice:

- The institute, in collaboration with the South African Police, set up a small multidisciplinary team consisting of an engineer, a psychologist and a motor vehicle technician for on-the-spot investigation of the causes of accidents as soon as possible after they had occurred. For practical reasons Pretoria and district was selected for this purpose. From time to time the team concentrated on accidents occurring at night, those in the rural areas and those involving pedestrians, thus providing experience in the systematic recording and analysis of accident data. Information from these accident case studies was made available to decision-makers in various statistical presentations. In 1981 a National Accident Sampling System was started leading to the establishment of a road safety data bank two years later.

A vertical photograph of a collision scene taken with a 'fish-eye' camera in an on-the-spot investigation by the road accident research team of the National Institute for Transport and Road Research.



- Alcohol consumption was identified as one of the main factors responsible for accidents, particularly in the more severe accidents. Recommendations by the institute to the National Road Safety Council led to the imposition of the legal blood alcohol limit of 0,08 per cent in 1973. Studies of the accuracy of alcohol breath-testing instruments resulted in the selection of appropriate equipment for law enforcement screening and specification requirements by the SABS.
- The institute's research on seat-belt usage began in 1973 and reports and recommendations to the Road Safety Council led first to publicity campaigns and eventually to legislation in 1977.
- Particular attention was paid to the identification of danger spots and their elimination through engineering improvements such as the resurfacing of slippery stretches of roads. The brake-force trailer, developed by the institute for the measurement of skid resistance, was used to identify slippery surfaces. Following the publication by the institute of a manual in 1972 on the identification and improvement of high-frequency accident spots, the Treasury allocated a million rand a year for the improvement of hazardous locations.
- Since pedestrian accidents were found to account for about half of all road accident fatalities, extensive research was carried out to identify the causes of such accidents and to devise methods of protecting the pedestrian. Measures included pedestrian crossings with appropriate signs,

foot bridges and underpasses as well as information for publicity campaigns and law enforcement.

Transportation research

Following the restructuring of the institute in 1976, transportation research was extended with the additional funding provided by the National Transport Commission. Following are some of the major projects undertaken in the ensuing years:

- Investigations to develop effective traffic counting procedures and to predict traffic flows were started in 1974 and subsequently expanded in close collaboration with provincial roads departments. These studies were later extended into an integrated system of traffic flow assessment when equipment such as the traffic engineering logger became available. These developments led to the compilation of a South African rural traffic model and recommendations for rural traffic counting.
- The geometric design of roads was significantly enhanced through the development and subsequent general use of the RODES suite of computer programs which allowed economic factors and road user costs to be taken into account. Another major development in this field was the compilation of a set of uniform geometric standards in collaboration with all rural road authorities. Acceptance of these standards led to the development of similar guidelines for urban conditions. Attention was later focused on guidelines for services in developing communities.
- Research on the role of buses in public transport preceded the development of management information systems as a base for the determination of bus subsidies. Recommendations were made later on bus priority lanes, the provision of bus services taking into account public preferences, the development of marketing strategies, and policies for public passenger transport.
- Research in the field of commuting yielded results with significant local implications and was internationally recognized. Innovative rating scales were developed to assess commuter attitudes to public transport. This work also contributed to a better understanding of the role of combi-taxis in commuting.
- Guidelines for transport planning procedures and techniques were drawn up. Special attention was given to co-ordination and integration of transport and land-use planning.

A Research Services Division was established in 1985 to manage all the institute's activities concerned with marketing its services. The overall policy of marketing research findings also took the form of personal contact with members of the private sector, the media and the authorities.

The marketing exercise included:

- Practical courses for road engineers and safety practitioners.
- Biannual publication of VIA, a document summarizing findings contained in NITRR research reports and other publications.

Marketing

- *Padlig*, a storage and retrieval system for keeping researchers in the institute and transport and road engineers throughout the country informed of the latest developments in their field.
- The collection and dissemination of information such as the International Road Research Documentation established in 1976, Southern African Development Co-ordination Conference in 1982, and the Storage and Information Retrieval System in 1984.
- The arrangement of conferences, symposia and courses, such as regional information forums and the annual road infrastructure course. The institute was also closely involved with arrangements for the Annual Transportation Convention from its inception in 1982.
- The compilation of an English-Afrikaans dictionary of road and transport terms started in 1975 and published in 1986.
- An affiliate scheme was introduced in 1985 in which private practitioners, local authorities, industry and others could participate in promoting the dissemination of research findings.

The institute participated extensively in both local and particularly international research forums through its representation, for example, on the Committee of the Transport Research Board in the USA and the International Committee on Transportation Research.

The institute was instrumental in the establishment of the Southern African Meeting on Roads in 1978, a forum with membership throughout southern Africa. Dr Kühn acted as co-ordinator and the secretariat was located at the NITRR. This forum not only proved to be of substantial technical benefit to the participating countries but also fostered understanding and collaboration on technical matters in the subcontinent. Participation in the institute's research was arranged with Malawi and Botswana and specialist consulting investigations were carried out for Swaziland, Lesotho and Zambia.

Applied industrial psychology

PERSONNEL RESEARCH

The industrial, technological and scientific developments brought about in South Africa by the Second World War stimulated a demand for skilled and high-level manpower for the country's rapidly growing economy in the post-war years. It was thought that industrial psychology might be helpful in upgrading the quality of the labour force.

Aptitude tests to improve the effectiveness and speed of training and to enhance operational efficiency had been adopted in the Allied military forces for all categories of personnel. For aircrews in particular, in view of the highly skilled and demanding nature of their duties and the relatively few people who possessed the requisite attributes, sophisticated psychological selection and classification methods were introduced in Commonwealth countries and in the United States. They proved to be highly effective.

On the initiative of Sir Pierre van Ryneveld, Chief of General Staff, a professionally staffed Aptitude Test Section of the South African Air Force was established in the early stages of the war under Dr S Biesheuvel, a peacetime lecturer in psychology at the University of the Witwatersrand. Though initially intended to classify pupil pilots into bomber and fighter categories, duties which demand different skills and personality attributes, it rapidly developed selection tests for all categories of aircrew, pilots, observers, navigators, gunners, radio operators and flight engineers. Events were to prove that operational success and survival depended on particular personality attributes, which could be assessed with a fair degree of validity before and during the training stages. In due course technical ground staff, including fitters, electricians, instrument repairers and mechanics, were also selected and classified with the aid of tests. The work of the section gradually extended beyond selection tests to problems of operational stress, the causes of flying accidents and the determinants of morale among operational squadrons and at flying schools. Towards the end of the war, the work of the Aptitude Test Section attracted the attention of state departments such as the Post Office and the South African Railways, and of a number of industries.

The Aptitude Test Section was by far the largest body of scientists and technicians that had ever been concerned with the application of industrial and personnel psychology in South Africa. At the height of its activities during the war it had a staff of nearly 90 including some aviation medical experts. As it was unlikely that the SAAF could maintain a regular unit of this kind during peace time conditions, many were progressively demobilized. At that time Dr Schonland was setting up the CSIR. Aware of the work of the section through his wartime activities, he was keen to keep together a nucleus of Dr Biesheuvel's team with its records. On Schonland's advice the Prime Minister, General Smuts, agreed in principle that the newly formed CSIR could concern itself with industrial psychological research and its application to the scientific and technological problems which the CSIR might encounter. It was a reasonable assumption that many of these problems would involve a human factor and that future economic advancement would depend to some extent on the availability and effective use of human initiative, abilities and effort. It was a highly imaginative decision to include in an infant scientific organization a discipline far less well established in practical application than the natural sciences.

Fortunately Dr Biesheuvel, who was more interested in continuing in personnel research than returning to his former post at the university, and a few of his remaining staff members were prepared to join the CSIR after their demobilization.

At its first meeting in October 1945, the CSIR Council agreed to a block allocation of £4 000 for the establishment of a Bureau of Research in Industrial Psychology with the object of disseminating and collecting information on the application of psychology to the work situation. It was to be a correlating agency and a centre for statistical work. The CSIR was understandably cautious in defining the functions and scope of the bureau so as to avoid conflict of interest with other bodies. The Bureau for Educational and Social Research of the Union Department of Education had made



Dr S Biesheuvel
Director, National Institute for
Personnel Research, 1948-1962

*National Bureau for
Personnel Research*

*National Institute for
Personnel Research*

valuable contributions in the field of test construction for scholastic and educational purposes under Dr E G Malherbe and later under Dr P A W Cook. The CSIR Council's intention was that its own bureau should do for industry what the Education Department's bureau was doing for education and in the social context. In addition, the Department of Labour was involved in preparing detailed job analyses and psychological job specifications as a guide for the placement of school leavers in appropriate jobs or training courses.

The bureau, with Biesheuvel as director, was formally established on 1 April 1946 on the understanding that it was to be regarded as an experiment and that all appointments would be for a probationary period of four years. At the end of this period the council would review the position in the light of the demand for industrial psychological services and research, and the success of the bureau on meeting them. CSIR funding provided for the appointment of three research officers, three scientific assistants and two administrative staff, all but one former members of the Air Force. An 'abstractor' post was authorized later that year. Any additional staff were to be appointed on contract with funds made available by industry and other organizations. In view of the restrictive nature of the term 'industrial psychology', the bureau was renamed the Bureau for Personnel Research and within a year the National Bureau for Personnel Research. Despite the small staff and lack of facilities, and contrary to the expectations of many, progress was rapid. Such was Biesheuvel's professional standing and experience that he succeeded in attracting such substantial contract work from the mining and other industries, the Defence Force and the Public Service, that after only two years the temporary bureau became the National Institute for Personnel Research (NIPR) in 1948.

At first the bureau was housed in a small detached building between the Mint and the main CSIR building in Visagie Street, Pretoria. According to Biesheuvel this 'was a miserable little building facing the main gate, in summer virtually unfit for human habitation, as the temperature rose to over 90 °F by lunchtime most days and stayed there for the rest of the afternoon. It had a tin roof, without heat insulation and work was further hampered by noise from the Mint's foundry next door.' It was impossible to do any testing under such conditions and therefore two laboratories of the National Physical Laboratory were placed at its disposal. As the bureau grew into an institute the need to provide relief became urgent, but the accommodation problem was complicated by the question as to whether the institute should be in Pretoria or Johannesburg. Eventually it was decided that the headquarters would be in Johannesburg, where much of the contract work for industry originated, but that a unit would remain in Pretoria to serve such clients as Iscor and the Defence Force.

In Pretoria the situation was eased by renting premises from the Department of Defence in Dequar Road close to the CSIR's head office. These premises, with additional space in the Central Medical Establishment at Voortrekkerhoogte, served adequately from 1947 to 1960. Thereafter the Pretoria branch occupied temporary accommodation in an adapted old farmhouse on the CSIR site at Scientia until a special-purpose building was built on the site in 1973.

In Johannesburg, the University of the Witwatersrand provided accommodation in temporary wooden huts on the campus. When the CSIR Council eventually agreed that a permanent home in Johannesburg was justified, the university made a site available close to Empire Road Extension on which the first properly designed building was erected in 1948. It was planned to house a maximum of 30 people and to provide testing rooms, laboratory space and offices. It was expected to serve the institute's needs for four years, but in fact it remained the headquarters until 1960. When in 1957 the institute was bursting at its seams, two buildings were made available for the Mines Research team at the former military hospital at Cottesloe. This team was moved there from temporary accommodation at Palmietkuil, part of Union Corporation's Grootvlei mine. Eventually the period of wandering ended when in 1962 the institute's fine new building, occupying a commanding position on the corner of Jan Smuts Avenue and Empire Road, was opened.

This was an event of some significance as the staff, which at that time numbered 124, were together at last in their own building after working for many years under difficult circumstances. To mark the occasion they took the opportunity of honouring Dr Biesheuvel, the founder director of the institute, who had done so much to win recognition for the discipline of personnel research and its applications in training and management. As a tribute to him the staff produced a special volume of *Psychologia Africana* devoted to the many-sided research activities in basic and applied research which had started and developed under him and which had won international recognition. They also instituted the Simon Biesheuvel Medal to be awarded annually to a behavioural scientist working in Africa for significant contributions to knowledge of man in Africa.



The headquarters of the National Institute for Personnel Research in Empire Road, Johannesburg, since 1962.



Dr D J Gouws
Director, National Institute for
Personnel Research, 1962-1965



Mr D J M Vorster
Director, National Institute for
Personnel Research, 1965-1977

*Personnel selection
and classification*

In the same year Biesheuvel left the CSIR to take up a position as an executive director responsible for the personnel function of the South African Breweries organization. He was succeeded by Dr DJ Gouws, formerly head of the Personnel Selection Division. Dr Gouws in turn left in 1965, to be succeeded by Mr DJM Vorster, a former staff member in charge of the Pretoria section of the NIPR.

The success of the NIPR was all the more remarkable because from the outset it had to pay its way by earning contract revenue. As the CSIR was probably the first official research organization in the world to adopt a system of contract research, there was little experience to draw on except from independent non-profit research foundations, such as the Battelle and Mellon research institutes which had sprung up in the USA during the 1940s. The procedures evolved by these institutes were, however, more relevant to the applied sciences and engineering than to personnel research, which at that time was not one of the generally recognized sciences. To the problems of opening a new field of research with limited funding and facilities were added the uncertainties concerning the CSIR's contract policy and practice.

Despite these difficulties, when the temporary bureau became a national institute in 1949, contract revenue amounted to £14 000 against total running expenditure of £34 978. It then had a staff of 63, of whom 37 were permanent. The council's policy provided for a permanent staff of this order and a temporary establishment based on contract revenue. With this small nucleus of permanent staff, undue reliance had to be placed on temporary staff and in order to maintain growth the institute had no alternative but to go for contracts and so the income treadmill had to keep going. One of the difficulties concerned the CSIR overhead charge of 100 per cent of the direct costs of the contract work. While this was eminently reasonable for a laboratory with sophisticated and expensive facilities, personnel research needed data for research which in some cases could be obtained only through contracts offered at a reduced price. Another consideration was that firms made a substantial contribution in terms of time lost by staff members required for testing, interviews, and so on. When in such cases the research data were of practical use to the institute, the contract price had to be adjusted accordingly.

The first major contract was entered into with the Department of Defence. This was to draw up standard selection procedures for the Air Force – based on statistical research on the Aptitude Test Section wartime data, including validation of tests for aircrew and technical ground staff. This work was later extended to include Army and Navy personnel. Routine testing of all new intakes into the SAAF was, at first, the NIPR's major source of income. The amount of time taken up by routine testing, as opposed to research, later gave cause for concern but was perforce continued until 1960. However, apart from income, this work provided useful psychometric material for test construction and validation. The Department of Defence also handed over a large stock of pencil and paper tests, and transferred the Aptitude Test Section's equipment and library to the CSIR, initially on loan and eventually as an outright gift. All scientific and confidential scientific data on military personnel research were handed over to the bureau for safekeeping.

Other work done for the Public Service included, for example, the selection of apprentices for the engineering branch of the General Post Office and a survey of the staff research requirements of the South African Railways and Harbours. As a result of this survey it was recommended that the Railways should start its own psychological unit under Dr P R Skawran who was well versed in industrial psychology and later became head of the Pretoria branch of the NIPR. Projects of this kind for government departments brought in no revenue if the costs were below £1 000 for the year. Departments had to obtain Treasury approval for any expenditure above this figure. Only the Department of Defence was willing or able to do so. The work was nevertheless undertaken without charge as the State was entitled to some direct benefit in return for its financing of basic research. Under these circumstances it was a remarkable effort on the part of the bureau to earn about two thirds of its upkeep.

Serving as its own guinea-pig, the CSIR insisted that NIPR selection procedures should be applied to all applicants for its own posts. For research staff this involved much agonizing over the difficult concept of creativity.

When the institute moved into research for industry it soon became apparent that there was a vast difference between the authority and leadership structure of a military and an industrial organization. The greater the involvement in personnel selection and classification in industry, the more it was realized that however important these procedures might have been in wartime, they could only contribute to solving part of the personnel efficiency problems in industry. The organizational aspects, group relations, work motivation, compensation systems, industrial relations and ergonomics all played their part, often cutting across any effects that might have been obtained by means of selection, classification and training. In this post-war situation it was therefore essential for the institute to diversify and to grow, and contract work for industry offered the only possibility of increased revenue for this purpose.

The institute's first major non-government contract was concluded with the Transvaal Clothing Manufacturers' Association for the construction and standardization of a battery of selection and classification tests for garment workers. This contract brought to light a problem which the NIPR encountered with the CSIR's general policy which favoured research supported by industry on a co-operative basis to avoid charges that individual firms would benefit at the expense of their competitors. However, in order to standardize tests for a representative organization such as the Transvaal Clothing Manufacturers' Association, the NIPR was dependent on the co-operation of individual firms in obtaining the required data. Unfortunately not all member firms were willing to invest in the amount of labour and time required for such an investigation. Thus it was found preferable to enter into contracts with individual firms rather than with representative organizations as once a test was standardized it could be made generally available with the CSIR's retaining copyright. In the light of experience it was found that, revenue earning considerations apart, the decision to enter or not to enter into a contract depended on scientific interest, prospects of a successful outcome, general usefulness in the national economy and the priorities of the institute.

Another early major assignment was a survey carried out for Iscor, which included a study of the incidence and causes of absenteeism and labour turnover among white operatives in the steel works, job evaluation of clerical and administrative staff, selection of applicants for apprenticeship, and development of screening and classification tests for administrative trainees. Work on this contract began in 1948.

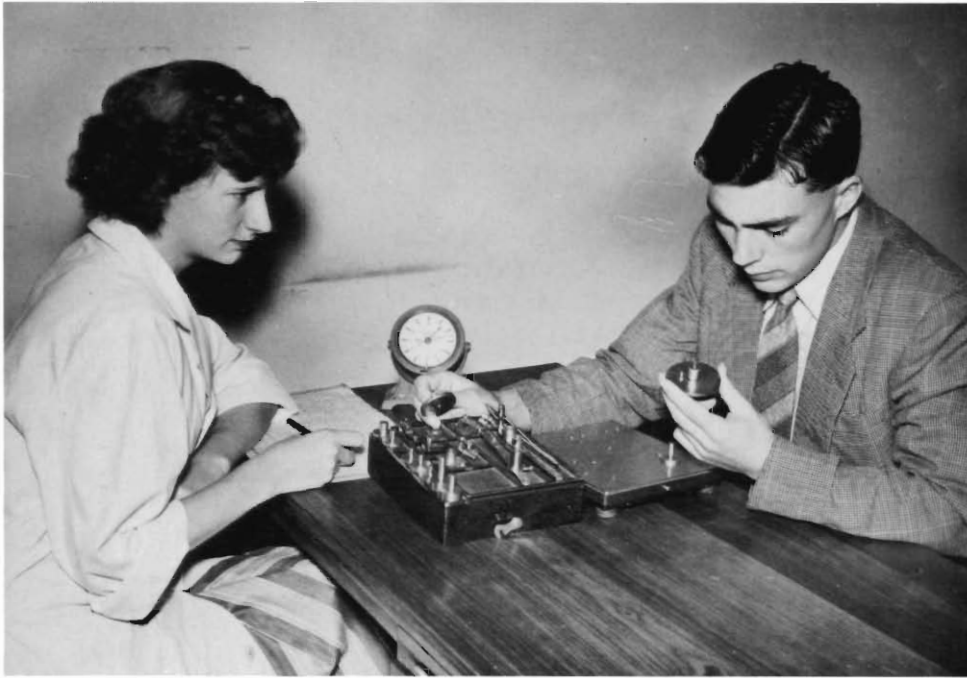
A third request came from the Industrial Development Corporation which, with the Calico Printers Association of Manchester, was in the process of establishing a cotton spinning and weaving industry (the Good Hope Textile Company) at Zwelitsha in the Ciskei. However, the institute was unwilling to go ahead with a study limited to the construction of a testing procedure, not only because the testing of black candidates including women straight from the rural areas might present unexpected problems, but mainly because difficulties in adjusting to industrial working conditions and urban living might be more important than the possession of the basic aptitudes required for the tasks. The company could not see it that way – it wanted testing done, no more. It was therefore decided not to go ahead with the contract. The institute was to encounter similar problems and resistance in the future; in the long run, however, its insistence on undertaking operational studies to determine the real staff problems facing a sponsor proved to be the correct policy although it meant foregoing much needed revenue.

Selection and training of mine workers

A request in 1947 from the Union Corporation to construct tests for the classification of black mineworkers and the selection of boss-boy trainees led to a cluster of investigations carried out for the gold mining industry. According to Dr Biesheuvel this was probably the most successful venture ever undertaken by the NIPR. As, in his view, these projects provided a model of effective research in the personnel domain, they are described here in some detail in his own words:

'A team headed by Scotty (later Dr) Hudson lived and worked on the Palmietkuil section of Grootvlei Mine for about four years. Its members, which included at one time or another Messrs Langenhoven, Naudé, Morkel, van der Walt, Masilela, Mkele, Mokoatle and Mbau, had red tickets, which qualified them to work underground. They all fully familiarized themselves with underground working conditions, with the tasks to be performed, with the measurement of underground productivity and with the personalities and attitudes of the people who worked there, both black and white. They became part of the mining community and became thoroughly acceptable to its members.

'Test construction posed some unusual and at first intractable problems. Recruits to be tested were black tribesmen drawn from many parts of southern Africa, speaking many different languages, knowing no English or Afrikaans, virtually completely illiterate, culturally diverse, unfamiliar with industrial tasks, many of them even unaccustomed to handling simple tools such as a shovel. Because they worked on contracts of from six months to two years at the most, and the labour force on one mine could be as large as 15 000, recruits would have to be tested in groups which could number more than 100 a day. The solution eventually adopted was to use sturdily



A candidate performs a mechanical aptitude test developed and validated by the NIPR for the selection and classification of apprentice artisans.

designed performance tests, such as sorting metal discs engraved with numbers or letters into appropriate compartments, a mechanical assembly task, putting together a large block using smaller ones in such a way that uniformly coloured outer surfaces were obtained, another test with blocks to be arranged to form patterns, etc.

"Tests had to be designed for mass construction at low cost, yet they should stand up to rough handling and remain standard even after prolonged use. Test construction involved finding media that would measure individual differences relevant to the tasks that had to be performed on the job. This led to research into the perceptual, manipulative and learning capacities of the subjects. The method of administration adopted was to use a silent film which demonstrated, using mime only, the nature of each problem, the right and the wrong way of doing the task, and the completed assignment. Shaking the head for right and wrong and pointing were the only gestures needed. A buffer test involving turning nuts on to bolts of different sizes and kinds served as introduction to familiarize the subjects with the mime procedure and with starting and stopping signals for which a gong was used. For each test there were a number of demonstration trials. The intention was that learning could take place both within each test and also from test to test, and by way of feedback from results. The five tests chosen for screening purposes were known as the General Adaptability Battery (GAB). Its purpose was to grade recruits into those suited only for unskilled labouring tasks, those who would respond to training for mechanical duties such as laying tracks, repairing cocopans underground and building matpacks, and those suitable for boss-boy training for which a previous tour of underground work was also necessary. A brief introduction to explain the whole procedure was given in Fanakalo, the lingua franca of the mines. For more specialized duties, such as driving winches or locos, other tests were available. For boss-boy selection, "leaderless group tests", based on those used during the Second World War by the British War Office selection boards, were used. Here problems such as transporting a heavy drum across a gap between two walls by a team of six men were used. No one was assigned the leadership role. Someone had to assume this role in the course of the tests.

'Scoring of the GAB tests, which gave quantitative results, was done by inspection by mine personnel trained in test administration. The appraisal of leaderless group performance was more tricky as it was ultimately subjective; but again with the aid of very detailed manuals, listing all kinds of solutions and behaviour patterns, it proved possible to achieve a high degree of consistency among the testers. The tests were validated both against training results and actual on the job performance after training, carried out by shift bosses and mine captains using criteria developed underground by the research team. Test reliabilities, despite the difficult circumstances, were satisfactory and validities ranged between 0,5 and 0,6 for various criteria. In boss-boy selection, the wastage rate for random selection was 27 per cent, for the traditional selection methods 16 per cent, and for test selection four per cent. The saving in training effort was appreciable both for the rank and file – all had to go through a surface training school which presented the major underground tasks in a realistically simulated underground section – and for the lengthy boss-boy training course.

'This was an important consideration in view of the vast labour turnover and short working tours. The tests proved acceptable to the industry and testing centres were erected at most mines. Standard testing procedures could be maintained despite the varying circumstances from mine to mine, which also involved variations in the composition of intakes and the personnel designated to apply the tests. Over the years more than a million workers went through the testing procedures and some familiarity with the nature of the test problems which could affect validity could be expected. When the NIPR was instructed to check whether the testing procedure had retained its validity in 1964 after it had been in use in some cases for more than 10 years, it was found that although standards had changed – which could be handled by adjusting selection cut-offs – reliabilities and validities had remained constant with minor changes only in the second decimal place. A truly remarkable performance.

'To make the testing procedure effective in practical use, a number of operational problems had to be solved. It was found, for example, that there was a high transfer rate underground, as many as 19 apparently unmotivated changes being recorded in one case in a tour of six months. This would defeat the object of job classification by means of tests and indicated the need for changing manning procedures and control. More difficult to deal with were the prevalent beliefs among mining personnel of tribal differences in aptitudes and job preferences. Experiments had to be conducted to test the validity of these beliefs and to change attitudes where necessary. The confidence which the mining industry gained in the competence and practical sense of the NIPR teams, led to many more contracts on job evaluation, training methods, accidents, reactions to compound conditions, preferences for employment on certain mines and its origins, and the motivations that led black workers to seek employment on the mines and to space tours at longer or shorter intervals. This was particularly important, as productivity depended greatly on the supply of black labour. The latter problem led to research in the areas where mine workers were recruited; for this purpose the NIPR had to engage personnel with social anthropological

training. A number of large-scale basic research projects was made possible through the facilities and plentiful supply of subjects available for investigation.

'Two of the most notable of these was a study by Hudson of the three-dimensional perceptual ability of blacks and another directed by me of factors determining their psychomotor learning abilities. White control groups were involved in these research projects. Both studies led to papers in international journals. Hudson's research and its conclusions have been quoted in textbooks and compilations of cross-cultural research findings. His work actually initiated a series of research projects by others to replicate his findings and to further investigate the important problem to which he had drawn attention.'

The success of the project was internationally recognized, and the testing technique was adopted in other parts of Africa and beyond and in other industries besides mining.

The teams working for the Public Service and Defence Department and the manufacturing and mining industries were backed up by teams with specialist functions. There was a test construction team which handled psychometric problems for other sections and constructed tests for general use. This group worked in close collaboration with the NIPR's own specialist workshop, where pilot models of equipment designed for aptitude testing and laboratory research on abilities could be experimentally developed. The kingpin in this work was Mr Dan de Wet, who had been responsible for equipment design and construction in the Aptitude Test Section of the Air Force, and later obtained a PhD degree from the University of Cape Town for his work in this field. He had remarkable insight into psychological processes and the ability to devise and make the apparatus needed to measure them. This was a great source of strength to the institute, particularly in its early aptitude oriented years.

A mathematical statistics section played an important role in making useful and original contributions to personnel research and practice, becoming a research entity in its own right. Various projects undertaken by the NIPR over a long period were relevant to the development and validation of psychological measuring instruments used in vocational counselling. From the outset it was recognized that in counselling, a test result should be used merely as an aid in advising those seeking advice on choice of careers. A major achievement was the standardization of the South African Wechsler adult individual intelligence scale, an adapted form of the American Wechsler-Bellevue adult intelligence scale.

Biesheuvel was able to persuade the CSIR Council that the new technique of electroencephalography (EEG) could be used for the objective measurement of the relationship between the brain and behaviour. In this he was supported by international authorities. When the first EEG machine, an Ediswan Mk I, was obtained by the NIPR in 1949, the discipline was at least 14 years old. What was new was the notion of using the EEG in the context of behavioural research, a facet of what came to be known much later as neuropsychology. The applications of this technique to the understanding of problems relating to the nature of intelligence, temperament, vigilance,

*Test design and
construction*

*Electro-
encephalography and
behavioural research*

the effect of alcohol and drugs on behaviour, and the involvement of neurological factors on fatigue and accident, proved useful both in theory and in practice. From the outset the NIPR's EEG Department, subsequently the Neuropsychology Division, as the only EEG facility in southern Africa at that time, faced a massive demand for clinical EEG examinations of patients referred by hospitals and private practitioners. This led to a number of important research projects on psychosis, epilepsy and culpability in criminal cases. Active assistance was given to various hospitals, universities and the South African Medical Services of the Defence Force in the establishment of clinical EEG units. A clinical and consultative EEG service continued to be provided for medical specialists, psychologists and the legal professions, later augmented by advanced procedures including evoked potentials and neuropsychological test batteries for the assessment of brain damage.

In the implementation of research results the NIPR made a breakthrough in the application of neuropsychological techniques, in the domain of personnel selection and the monitoring of performance in the work situation, by the introduction of the EEG as a screening technique. This technique was used in the selection of pupil pilots (1964), naval divers (1965), submarine officers and crew (1967), drivers of extra-heavy duty vehicles in an opencast mine (1981) and controlroom operators in a nuclear power station (1982). The EEG was also used as a reference document in the event of unplanned deviations ('accidents') in the work situation.

At this time, as the institute began to study the effect of psychosociological factors upon productivity, job satisfaction, absenteeism and labour turnover, the composition of the research teams underwent a change to cater for diverse areas such as work measurement, training and problems associated with attitude and motivation. Accordingly the fields of research activity were more clearly defined in the early 1960s and the divisions were reconstituted for greater functional specialization. The institute then had four main divisions, each containing sections orientated either to study basic psychological problems relevant to the institute's needs or to undertake applied research. The divisions were responsible for the following: Research into the selection of workers (personnel selection and vocational counselling); research into the use made of workers (work study, training and interpersonal and intercultural relations); research into test construction and experimental design (psychometrics and mathematical statistics); experimental research (neuropsychology, ergonomics, studies in comparative psychology, and studies in perception, temperament and personality).

Whereas in the earlier period the institute had played a pioneering role in the introduction of the scientific approach to personnel management practices in southern Africa, in the 1960s and 1970s these practices were, to an increasing extent, well established in the business and public sectors. In this period it was therefore more concerned with the refinement of personnel management procedures and with the growing recognition of the acute shortage of skilled manpower.

For instance, the general adaptability test battery which had been constructed by the NIPR more than 20 years previously to determine the

trainability of illiterate black labourers was upgraded in 1971. The Chamber of Mines estimated that the application of these procedures had saved the industry over R2 million, mainly because hundreds of candidates could be tested simultaneously and placed in jobs best suited to their abilities. While this battery still functioned satisfactorily if appropriately used, various factors such as greater exposure to the Western way of life had necessitated a new instrument for classifying this industrially unsophisticated labour force. At the request of the Chamber a new classification test battery was constructed and validated. This battery was the outcome of extensive psychometric research and, while it retained much of the simplicity of the administration of the old battery (the film technique, for example), it took into account the general development and intellectual sophistication which had taken place among rural blacks. This revised classification test battery was extensively used by the mining and secondary industries.

Classification test battery revised

It was estimated that this new modified battery was used for testing more than four million recruits. Income from the sale of these and other tests to both the public and the private sector amounted to R1 million between 1975 and 1985. The use of psychological tests was partially prescribed by a law administered by the South African Medical and Dental Council, which has jurisdiction over psychologists, psychometrists and psychotechnicians. Other test users have since 1975 been supervised and registered by the Test Commission of the RSA, affiliated to the International Test Commission, with the aim of controlling and promoting the use of psychological tests. The Test Commission of the RSA, although recognized by the South African Medical and Dental Council, has at the time of writing yet to receive statutory status in South Africa.

In 1975 a major project on the identification of training needs of black labour in a semi-agricultural, labour intensive and predominantly rural industry was undertaken. The aim was to improve the use of manpower through training in order to meet the growth demands of the future. A training approach previously developed by the NIPR was extended to include a job description format whereby training content and training complexity for jobs performed by black workers could be identified. The information obtained in this way was necessary to make effective training recommendations. The model of the training approach was also amended to allow for the determination of a training strategy, namely, finding out the most effective way in which a large number of workers throughout an organization or industry could be trained. This was an aspect which had frequently been overlooked in the design of training systems, and the flexibility of the NIPR's model made possible its adaptation to meet the demands of specific situations.

Training programmes

This training project led to a study of general staff practice management and working conditions in industry. These were found to vary from company to company, and while the attitudes of management were generally positive and sympathetic towards black workers, staff practices were usually poorly formulated and erratically implemented.

It was found that a modified approach was necessary for the training of black workers since traditional industrial training techniques did not al-

ways make provision for the relatively low educational level of the rural black population and the cultural and social differences between black and white groups. The NIPR consequently adopted an approach to training based on the principles of programmed instruction.

On behalf of the Boithusong Training Centre in Bloemfontein, an experimental training programme for black supervisors was developed by the NIPR and used by the centre for the training of supervisors in local industrial organizations. At the request of the Forestry Council, the programme was modified for use in the forestry industry and offered by the council's training unit. On behalf of the Transkei Development Corporation training systems were developed for a newly established forest products company in a remote plantation area of this territory. This required a modified approach which provided for black workers to progress to management level. An induction as well as a short-term training system was developed to facilitate commissioning of the sawmill activities.

A pilot programme for the training of higher level, literate black supervisors was implemented and evaluated in the forestry and construction industries and at in-service training centres. Results indicated that the course contents were satisfactory but that standards of presentation varied considerably, depending on the skills and experience of the instructor. As a result of these evaluation studies, a programme manual for trainees was redesigned to facilitate learning, ending up with 11 self-contained modules. A comprehensive instructor's manual containing detailed instructions for the presentation of each module as well as suitable case studies, role plays and practical exercises, was developed to improve the standard of training. After further evaluation, it was decided to release the new programme to industry in April 1978. Subsequently manuals were supplied to 140 organizations in Zimbabwe, South West Africa and Transkei. Regular courses were also presented by five in-service training centres. About 800 of these programmes, which were registered with the Department of Manpower, were sold to industry every year.

*6M Training
Simulation
Programme*

Management in industry had long recognized the need for employees with a predominantly rural background to be better informed on the manner in which a modern industrial organization functioned. Accordingly, the institute designed a model to illustrate the development and operation of manufacturing concerns and other organizations by simulating the actual functions of a modern company. The model, called the 6M Training Simulation (Men, Machines, Materials, Money, Management, Market) was introduced to explain the interaction between all these factors. The model was presented by trained instructors to small groups of eight to 10 in the form of seven 50-minute modules covering the following aspects: Formation of a company, the sources of the company's money, factors influencing the selling price and turnover of the company's products or services, competition, profit, loss, causes of waste within the company, and efficiency.

The technique makes use of well-established training principles, and the absence of written material makes literacy unimportant. Throughout the training, stress was laid on the link between the company's strength and its advantage to the employees, as well as on the positive influence which the

collective effort of the employees could have on the strength of the company. The 6M Simulation was geared to the needs of specific organizations to enable employees to accept the model and the concepts as directly applicable to their own particular organization.

By 1985 some 225 organizations were using the 6M Programme. Reported advantages included: Positive changes in worker attitudes and behaviour, significant improvements in the understanding of business concepts, savings of R300 000 in a particular organization, a reduction of 66 per cent in labour turnover in another organization, and refusal by workers to strike because they realized what the economic consequences would be.

A survey indicated that some 45 000 workers had undergone this training programme. The contribution by the 6M Programme to the increased productivity of the manpower of South Africa was acknowledged in 1984 when a Productivity Award of the National Productivity Institute was conferred on the institute.

These developments reflected an increasing awareness in commerce and industry of the need for professional personnel management, and by 1974 there were many openings for black personnel managers. A manifestation of this was the increasing difficulty experienced by the institute in filling posts for black graduates. At that time there were some seven vacancies for graduates with BA or BA(Hons) degrees in the institute. These staff members had proved invaluable over the years in many divisions of the institute but mainly in the Industrial Ethnology Division. They interviewed black subjects in projects of many kinds, such as attitude and morale studies, studies of absenteeism, labour turnover and motivation, and operational surveys and their contribution in the interpretation of data had been of great value. Previously it had been possible to keep these staff members for many years, mainly because there were few employment opportunities outside the institute with comparable conditions of service.

Vocational guidance services were provided by the institute from 1955 onwards. Most of the clients were school leavers but mid-career counselling was also provided. Between 1975 and 1985, vocational guidance was provided to 17 000 people. Follow-up studies indicated that more than 90 per cent of them were satisfied with the counselling. Intending university students who followed the advice of the institute took an average of 3,8 study years to obtain a bachelor's degree against the 5,6 years for those who did not.

In the development of vocational counselling services, special attention was given to cognitive abilities, language and numerical skills and vocational needs and preferences, as well as to the achievement, motivation and occupational aspirations of black youths. The policy of the institute was to assist other organizations as far as possible with the establishment of facilities for career guidance. For example, it collaborated in the development of a student counselling service at the University of Fort Hare and at the University of Transkei. A survey carried out in 1978 for the Urban Foundation highlighted the need for a vocational counselling service to the community to help individuals in making balanced career choices and in under-

*Vocational guidance
services*

International co-operation

standing the implications of career planning. This led to the extension of the Education Information Centre to include a centre for work placement and vocational counselling for black people. In order to communicate vocational information to the widest possible spectrum of individuals, a training programme explaining counselling concepts in general terms was designed for use by teachers, personnel managers and others concerned with counselling.

The pioneering work of the NIPR was not without its international impact. At the invitation of the British Commonwealth Advisory Committee on Defence Science, of which Dr Schonland was a member, South Africa was asked to examine and report critically on the personnel selection methods of all the armed forces of the Commonwealth. In accordance with this request, Dr Biesheuvel presented a paper in London at the June 1950 meeting of the committee. Arising out of the discussion it was agreed, on South African initiative, to form a subcommittee on military psychological questions. As a delegate to the main committee's conferences in India, Canada and Australia, Biesheuvel also attended the service psychologists' meetings where papers prepared by NIPR were presented. Unfortunately this fruitful association came to an end when South Africa left the Commonwealth.

During the 1950s, the NIPR's classification and selection procedures were applied on the copper mines of Northern Rhodesia, a gold mine in the Gold Coast, in the West African army for the selection of artisans and cadet officers, and several industrial and government departments in Kenya. A major project was undertaken between 1959 and 1961 in association with Dr H Holleman, director of the Institute of Social Research of the University of Natal, on behalf of the Northern Rhodesian Chamber of Mines and the Anglo American Corporation to determine the attitudes of white mining employees towards life and work on the Copperbelt and at Broken Hill. All the fieldwork was done by NIPR teams under Biesheuvel's direction. This project eventually led to a joint publication by Holleman and Biesheuvel, *White Mine Workers in Northern Rhodesia 1959-60*, published in 1973 by the African Studies Centre of the University of Cambridge and the Afrika-Studiecentrum of the Netherlands universities in their joint series, *African Social Research Documents*.

Through the Inter-African Labour Bureau the NIPR was asked to take the lead in a study of labour productivity, a project jointly carried out by South Africa, France, Belgium, Portugal, Britain and the Central African Federation. All adopted the research design developed by the NIPR, and the South African part of the study was submitted in 1960 to the Commission for Technical Co-operation in Africa and the Scientific Council for Africa South of the Sahara, under the title *The Black Industrial Worker*.

Investigations by the institute, carried out in Uganda and South Africa from 1956 to 1959 in collaboration with the British Medical Research Council and the World Health Organization, indicated a retardation in brain development as a result of severe protein and carbohydrate malnutrition. This finding sparked worldwide research on the subject which substantially confirmed the NIPR's findings.

The NIPR was actively involved in South Africa's contribution to the International Biological Programme (IBP). Studies were carried out on the work attitudes and motivational disposition of selected black groups living in rural and urban areas. Some of them still followed traditional ways of life, although influenced by contact with Western society, while others were more fully adapted to the demands of urban living and of a materialist-technological society. Cross-cultural research has in fact been a continuous thread running through NIPR projects from the beginning. In view of the multi-ethnic composition of South African society, it is fitting that the institute should have made a major contribution to knowledge about the behavioural aspects of African cultures, about acculturation problems arising from contact with Western civilization, and about methodology in cross-cultural studies.

For the benefit of students of the behavioural sciences in Africa, two valuable research aids were compiled. The first, an annotated bibliography on the aptitudes and abilities of people in Sub-Saharan Africa*, was unique because the subject was covered chronologically from the first available writings to those of 1963. The second annotated bibliography (a continuation of the first)**, in addition to listing all behaviour studies of populations in Africa, brought the list of publications on abilities up to date. Whereas the first bibliography covered 521 titles appearing over 180 years, the second listed about 2 500 out of a total of 4 500 published during the relatively short span of 15 years.

Mr Vorster retired from the NIPR at the end of 1976 and was succeeded by Dr G K Nelson, the assistant director who had first worked at the institute as a vacation student in the Neuropsychology Unit in 1953. Subsequently he played a leading role in putting electroencephalography in South Africa on a scientific footing and contributed significantly to an understanding of what the EEG could reveal about brain functions.

From its early beginnings in 1946 as a temporary bureau under the wing of the newly established CSIR, the NIPR evolved into a major research organization in the field of the behavioural sciences. By the 1980s the scope of its activities had extended beyond the immediate fields of responsibility of the CSIR and had many interfaces with those of its sister organization, the Human Sciences Research Council (HSRC), which had been set up as a statutory body in April 1969. These two councils, after reviewing the situation, recommended to the Government that the control of the NIPR should be taken over by the HSRC. This was accepted on the understanding that the NIPR would retain its identity and continue to work with the CSIR in certain fields on a contract basis. The transfer of the NIPR became effective on 14 June 1985.



Dr G K Nelson
Director, National Institute for
Personnel Research, from 1977
(Chief Director from 1983)

* *Aptitudes and Abilities of the Black Man in Sub-Saharan Africa, 1784-1963*. An annotated bibliography compiled by L E Andor. National Institute for Personnel Research, Council for Scientific and Industrial Research. Johannesburg, 1966.

** *Psychological and Sociological Studies of the Black People of Africa, South of the Sahara, 1960-1975*. An annotated select bibliography compiled by L E Andor. National Institute for Personnel Research, Council for Scientific and Industrial Research. Johannesburg, 1983.

Common Services

TECHNICAL SERVICES

When the CSIR established the National Physical Laboratory and the National Building Research Institute in 1946, they each set up their own technical workshops. This need had been anticipated by Dr Meiring Naudé. Indeed, when he became the first director of the NPL he had insisted that qualified and experienced instrument-makers should be recruited from overseas. In his view, artisan training in South Africa did not at that time cater for the high degree of precision required for research in physics.

Suitable equipment was difficult to obtain and funds were limited in those immediate post-war years. The CSIR therefore decided to concentrate the existing specialized workshop facilities and staff in a central workshop serving the CSIR as a whole, leaving only basic tools and simple workshop equipment in the laboratories. The task of the workshop staff was to design, construct and maintain special-purpose instruments and apparatus in close collaboration with the research workers. Allocation of time was controlled by a committee of directors of research institutes, under the chairmanship of Dr Naudé, with the secretary/treasurer of the CSIR, Mr J R Sorrie, as secretary. The costs of staff time, materials and components for each project were charged to the institutes for which the work was done. This simple costing system served well and kept overheads to a minimum.

The policy of designing and making special purpose instruments and apparatus in-house was founded on the need for close contact between research and workshop staff, particularly in the design stages. Outside firms were seldom interested in making complicated one-off items and often could not meet the demands for ultra-high precision.

Central Workshop

When the Central Workshop came into being the staff of 12 included tool-makers, cabinet-makers and two instrument-makers. Mr E O Garnett was the manager and Mr J van der Staaij, former head of the instrument workshop of the research laboratories of the Shell Company in Amsterdam, became foreman. Although South African technicians were available who had gained experience in precision tool-making and die-making during the war, there were not enough of them to meet the demands of the rapidly developing research institutes for workshop services, particularly in precision engineering. At this stage Dr Naudé's policy of recruiting skilled workers from overseas began to pay off and by October 1948 five of the six vacant posts had been filled. To provide for future needs it was decided that the CSIR itself should undertake the training of scientific instrument-makers, and in 1949 the first two apprentices were employed.

Accommodation for the workshop in the CSIR's temporary premises in Visagie Street, Pretoria, was inadequate. Although work was placed out with private firms, the increasing workload caused congestion on the machine shop floor and no provision could be made for a drawing office. Thus it was that one of the first buildings to be completed on the CSIR's permanent site, Scientia, was for the Central Workshops. Equipped with the most modern machinery, it was a great event for the staff when they moved in in 1955. With Garnett's transfer to the South African Bureau of Standards,

van der Staaij became head. At that time the main components were instrument-making with 26 staff members, woodworking with six, electro-technical with five and sheet metalworking with two. A branch instrument-making workshop was set up at the cyclotron. This was the first of its kind, and from 1957 onwards branch workshops were established in most of the institutes.

Instrument-making constituted the hard core of the workshops activities. Some outstanding examples of their achievements in collaboration with research staff were a primary-standard barometer, a direct reading attachment for the spectrograph, and the polariscope.

Woodworking under Mr F Kolb also played an important role in such activities as pattern-making for foundry moulds for complex metal castings, which required work of great precision and a comprehensive grasp of foundry techniques. In addition to scale models for acoustic design of auditoria, air-screw blades for aeronautical research and wind tunnels, a wide range of equipment was made from plastic materials and fibreglass.

Intricate and exacting sheet metalwork became increasingly important, particularly in the field of aeronautical research and aeromechanics.

Apprentice training was expanded under the supervision of van der Staaij, who prepared a schedule of tasks to be performed to ensure that all the necessary skills were acquired by the trainees. By 1956 eight apprentices had qualified as instrument-makers while seven were in training. As initially the Trade Testing Centre of the Department of Education did not have the necessary facilities for testing instrument-makers, arrangements were made for these tests to be done at the CSIR under the supervision of the Trade Testing Centre. These tests, which required the completion of tasks to a high level of precision in the specified time, were designed for the testing centre by van der Staaij.

In 1958 the CSIR decided that all its services of a technical nature should be brought together under centralized control in a Technical Services Department (TSD) under Mr van der Staaij. In 1963 he was promoted to director of TSD, by which time the services included stores, transport, photographic, duplicating and printing services. Together with the Central Workshops, these comprised 16 divisions with a total staff of 144.

The main stores, which were taken over by the TSD in stages, were the technical and stationery stores of the Administrative Services Department, the electrotechnical stores of the National Physical Research Laboratory and the chemical stores of the National Chemical Research Laboratory. Through advisory committees the main user-organizations had a say in the quantities and quality of stores which should be maintained. By the end of 1972 the combined staff was 32 and stores were valued at R360 430.

Transport services were a somewhat tougher assignment. Until 1952 the CSIR was able to use the services of the Government Garage but thereafter had to build up its own fleet of vehicles. This posed no real problems but with the development of the CSIR's site at Scientia, east of Pretoria (which initially lay outside the Pretoria municipal area), the transport of staff to and from work presented some difficulties. At first the CSIR arranged with the Municipality to extend certain bus routes from the centre of the city to

*Special purpose
equipment*



Mr J van der Staaij
Director, Technical Services
Department, 1963-1972

*Technical Services
Department*

Stores

Transport services

Graphic Arts

Scientia and subsidized the fares beyond the municipal boundary. The CSIR itself provided transport for black workers. Later on buses were hired from the Municipality and PUTCO, and minibuses were bought to serve outlying areas. By 1972 the Transport Depot had 165 vehicles (including those assigned to regional laboratories of the CSIR) and a staff of 40.

As the CSIR developed, the need for in-house printing and duplicating services increased. For this purpose a Graphic Arts Unit was set up under the TSD and in 1968 it combined these services with its photographic services to form a Graphic Arts Division. In common with all research organizations the CSIR's most pressing need was for the quick and cheap production and reproduction of documents with many illustrations and a limited print-run. Conventional printing with moveable type and metal blocks was too slow, cumbersome and expensive. The same considerations applied to duplicating services using wax-sheets, microfilming and photocopying. By the 1960s alternatives were beginning to emerge, and the Graphic Arts Division was entrusted with the task of printing and reproducing more and more documents to meet seemingly impossible deadlines, by making use of a rapidly evolving technology, at competitive costs. In the end this activity was mostly computerized with each institute doing its own word processing or electronic composing and the copy being fed by floppy disc or by way of the mainframe computer to the print room of the Graphic Arts Division.

In the earlier years it had been expedient, though not very productive, for experienced instrument-makers, in association with the scientists and engineers, to do their own designing and production of working drawings. However, in view of the increasing volume of highly specialized engineering work, qualified designers and draughtsmen were appointed to form a central design drawing office. Branch design, drawing and tracing offices were also incorporated into TSD.

Facilities for the training of scientific instrument-makers were developed during the 1960s and 1970s to meet the increasing demand for these specialist technicians.



The TSD also took over all responsibility for glassblowing work, which had previously been done in individual institutes.

In 1959, when nationwide advertisements for eight vacancies for instrument-makers failed to yield results, a recruiting drive in the United Kingdom, the Netherlands and West Germany had an excellent response and all the posts were filled with well qualified and experienced technicians. However, as a result of a survey of the requirements of other research organizations and with an eye to the future, the annual intake of apprentices was increased from seven to nine.

As the number of apprentices increased and it became more difficult to ensure that all the trainees received instruction in all the skills required, it was proposed that training should be concentrated in a separate building as a national training centre for instrument-makers. By agreement with the education authorities, funds for this purpose were approved by the Government in 1965, and in 1968 a building equipped for the training of 43 apprentices and for the installation of equipment for specialized and new emerging technologies was opened. Entrance requirements were matriculation with science and mathematics or the National Technical Certificate (NTC), Part III. For their theoretical studies apprentices were supported in study for the NTC Part IV and V, or the National Technical Diplomas, at a College for Advanced Technical Education. At the centre they received a comprehensive training in making delicate instruments and precise mechanical equipment. They were issued with a series of six manuals developed by the first head of the Training Centre, Mr P van der Ryst, on precision engineering necessary for instrument design and manufacture, and were given only those practical assignments which had a high training content. There was so much interest in these courses that it was never necessary to advertise them, and the TSD was justly proud that 90 per cent of the candidates passed their trade tests at the first attempt.

*Technical Training
Centre*



The numerically-controlled machines workshop in TSD.

Technological innovation

During the 1970s the training centre under Mr D Wilke was extended to meet the increasing demand from other research organizations, universities and industry for scientific instrument-makers capable of maintaining process control instruments and developing and manufacturing apparatus. Of the 58 apprentices undergoing training some 15 qualified each year, of whom about half were appointed to permanent posts at the CSIR. The training policy was based on the manufacturing requirements of CSIR research institutes and certain other bodies and kept pace with technological developments overseas, such as numerically-controlled machines and other automated manufacturing methods.

The TSD played a significant role complementary to that of the national research institutes in evaluating new technologies developed abroad and in transferring to industry those which were found to be relevant to local circumstances. The numerically-controlled machine acquired by the TSD was the first to be used in this country. Gradually other highly specialized new techniques were introduced including electron-beam welding, thread grinding, electrodischarge machining and plastic injection moulding.

Facilities which were established in the Photographic Division for the manufacture of printed circuit boards for electronic engineers were extended to include the manufacture of accurate multilayer boards (complementary to the integrated circuit facility established in the National Electrical Engineering Research Institute). This made possible the manufacture of printed circuit boards to a standard of accuracy and precision which previously could only be obtained from overseas. Many of these new technologies were introduced to meet the needs and growing demand of defence research requirements.

As the unique services of the TSD became known, more and more requests were received from organizations outside the CSIR for the design and manufacture of special purpose equipment. Although it was the general policy of the CSIR to avoid competition with private industry and to farm out work wherever possible, assignments were undertaken for outside bodies provided that it could be established that the work, because of its specialized nature, could not be undertaken by South African industry. In accordance with this policy, instruments and apparatus were designed and made for astronomical observatories, the Departments of Forestry, Transport and Agricultural Technical Services (including the Veterinary Research Institute at Onderstepoort and the Tobacco Research Station at Rustenburg), the H F Verwoerd Hospital in Pretoria, several universities and private firms.

Some indication of the range and scope of the facilities and expertise which were developed is provided by the following examples of projects in which the TSD assisted with the design, development and manufacture of specialized equipment:

- Disposal plant for used bank notes for the Reserve Bank, designed and made in collaboration with the National Mechanical Engineering Research Institute.
- Modernization of the drive mechanisms for the electrical system of the Boyden Observatory's 60-inch reflector telescope near Bloemfontein.

- Artificial limbs with unique hydraulic control which were later manufactured commercially in England from working drawings prepared by the TSD.
- Heart valves with supporting test apparatus.
- Mobile water desalination unit for the National Institute for Water Research for use in the treatment of ground water on farms in South West Africa.
- Microtome for the dissection of brain tissue samples in pathological investigations.
- Wire rope test apparatus for the Mining Equipment Research Unit.
- Rotating all-sky camera.
- Variable depth sampling apparatus for use in brewing tanks for the CSIR's Sorghum Beer Research Unit.
- Fibreglass rotor blades and other autogyro parts for the CSIR's Aeronautical Research Unit.
- Small-scale controlled-rate bitumen sprayer for the National Institute for Transport and Road Research.
- Deep-sounding device for measuring the shear strength and compressibility of subsoils *in situ* for the National Building Research Institute.
- Triaxial cell for the measurement of deformation of bitumen-bound road samples under pressure for the National Institute for Transport and Road Research.
- Development of a washing machine for babies' bottles in hospital maternity wards for an industrial firm.
- Development of a polishing machine for use in the manufacture of cutlery for an industrial firm.
- Development and manufacture of a coil-spring winding machine for an industrial firm.
- Design and development of a wattle debarking machine for the Wattle Growers' Union of South Africa.

The latter affords a good example of a technical solution to a local problem. For the production of wattle extract, the wattle bark has to be removed in strips from the logs and branches of felled wattle trees to avoid drying out of the bark and consequent formation of chemicals which cause discoloration of the wattle extract. Existing debarking machines could not replace the traditional manual wattle debarking as they were designed for cleaning the logs of other species of trees and removed the bark in chip and not strip form. A unique, relatively simple and low-cost mobile wattle debarking machine was therefore developed which could be towed into a plantation and driven from the power take-off of a tractor. An industrial concern undertook its commercial manufacture.

In 1970, following an in-depth study by Mr K R McCusker and Mr P H Trendler of low-cost automation techniques which had been developed, in

Low-cost automation

the United Kingdom and on the Continent, it was decided to set up a Low-cost Automation Centre within the TSD. The object was to provide a service to industry through which engineers, designers, technicians and maintenance staff could be trained in the application of these techniques.

Simulators were designed and developed for experimental and training purposes. These were modular panels on which were mounted the various items of equipment for controlling, for example, transport, handling, sorting, moving, counting and inspecting of production items. The simulators were used by trainees for experimental mock-ups. As this type of automation offered versatility and low capital outlays, it was applicable to small industrial undertakings. Symposia and seminars were presented in various centres in 1971 to inform industry of these techniques. By the end of 1972 the TSD had presented seven eight-day basic courses and two five-day advanced courses which had been attended by representatives of 32 industrial organizations and several universities.

Individual firms reported savings of from R1 800 to R18 000 a year as a result of successful applications of these techniques. As a result of this initiative two universities and a technikon included low-cost automation in their curricula and at their request the TSD made simulators for them. These courses, seminars and associated technical services paved the way for the TSD to become involved in providing engineering advisory services to manufacturing industry.

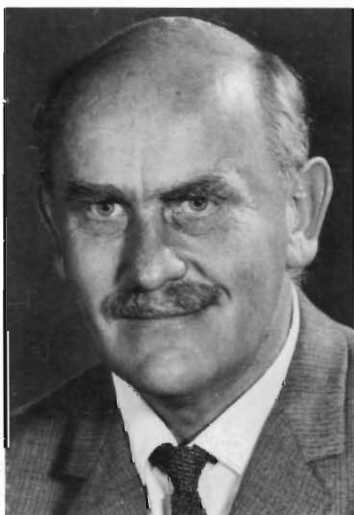
In 1972 Mr van der Staaij, who had built up the TSD around the Central Workshops, retired after 25 years' service with the CSIR. He was succeeded as director by Dr T Hodgson, former head of the Heat Mechanics Division of the National Mechanical Engineering Research Institute.

Under Dr Hodgson the advisory services to industry were formalized, in 1975 with the establishment of a Production Engineering Advisory Service (PEAS) within the Technical Services Department. The main thrust of this activity was concerned with technology transfer in the metal-working industries, as it was found that some 84 per cent of the firms in this important industrial sector had fewer than 100 employees. One of the primary aims of PEAS was to help these firms to take advantage of technological advances.

Special-purpose machines were developed, modified and, if necessary, automated for use by manufacturers. Thus locally designed machines could be manufactured at a cost substantially lower than that of similar imported machines – a saving made possible by developing the machines specifically for lower outputs to meet the requirements of the limited local market.

Investigations into improved cutting tools and machining techniques enabled industrialists to obtain maximum metal-removal rates within the capabilities of existing machines, thereby increasing productivity. Successful tests on the use of cubic boron nitride tools on extremely hard materials evoked considerable interest when reported in a paper read at an international conference on production engineering in Australia.

Training in various aspects of production engineering was developed and in 1980 more than 600 delegates attended the various courses offered by



Dr T Hodgson
Director, Technical Services
Department, from 1972
(Chief Director 1983-1984)

PEAS; these were short, intensive courses in quality control, low-cost automation, efficient machining, metrology and programming for numerically controlled machines. Particular interest was shown in the various courses in quality control which enabled candidates to obtain practical knowledge as well as formal qualifications recognized in the USA and Britain in the field of quality control engineering. Under the guidance of the Industrial Training Section of PEAS there was a pass-rate of more than 80 per cent of the candidates who had enrolled for the examinations of two educational institutions overseas.

In the first 10 years of its existence, PEAS trained thousands of South Africans in skills which previously had to be imported, enhanced business profits through assisting firms to improve productivity and quality control, and assisted firms to acquire the knowledge, skills, equipment and know-how to manufacture goods which previously had to be imported.

In 1984 PEAS was transferred from the Technical Services Department to become a fully fledged unit of the National Mechanical Engineering Research Institute. The reorganization was made to allow PEAS to expand and provide a more diverse range of services for industry and reflected the continuing commitment of the CSIR to meet the broader technology transfer needs of local industry.

Dr Hodgson, who had started PEAS and guided its progress through the decade of its existence, continued as head of the unit. He remained in this position until his death in 1985.

Mr Patrice Lasserre came to South Africa from Belgium to take up the position of head of the Technical Services Department.



Mr P Lasserre
Head, Technical Services
Department, from 1984

ADMINISTRATION AND MANAGEMENT

Dr Schonland had no illusions about the limitations of State-funded research organizations when he set up the CSIR in 1945. He was aware that research organizations that operated within the Public Service had not been entirely successful, because the Public Service, he argued, had been created and developed for quite a different purpose.

As he wrote in the CSIR's first formal publication, *Objects and policy of the CSIR* (see p. 13), 'The Council is a corporate body responsible to the Prime Minister for the formulating and the implementing of a national policy for scientific and industrial research. It consists of a full-time president, who is its chief executive officer, and nine members chosen for their eminence in the fields of science and industry.

'... As in most other countries, it has been made a corporate body outside the Government Service in order to give it the flexibility and the freedom which is essential for the atmosphere of scientific research. It is, however, responsible to Parliament, through the Prime Minister, for its programme and its estimates. Its accounts are audited by the Auditor-General*. ... Although the Council will derive its basic revenue from a Parliamentary Vote, it is expected that it will receive a substantial income from other sources.'

* Full designation Controller and Auditor-General

Staffing policies

In establishing the CSIR, Dr Schonland had in mind the need to create career opportunities in research which would attract a fair proportion of the country's most able young men and women. He argued that, if they could devote their immediate postgraduate years to research with modern facilities, unfettered by a teaching load or the urgent practical needs of industry, they would be better equipped to move on to senior positions in the universities or in industry. To meet this requirement he introduced four main categories for the staffing of the CSIR, namely research officers (minimum qualification a four-year university degree), technical officers (three-year university degree), technicians (qualified artisans) and administrative staff. The salary scales which were adopted were fairly heavily differentiated in favour of the research officer grades, the highest grade, that of principal research officer, being roughly equivalent to that of a university professor. Initially, therefore, the director of a 'national research institute' of the CSIR had a reasonably elevated status in professional circles.

To facilitate the interchange of staff between the CSIR and the universities, Dr Schonland arranged for the inclusion of CSIR staff in the University Teachers' Provident Fund. Not only were the superannuation benefits of this fund less favourable than those of the Public Service Pension Fund but brought with it a requirement that all posts established by the CSIR had to be approved by the minister responsible for the CSIR as well as the Minister of Finance. To some extent this condition negated the autonomy of the CSIR in determining the salary structure for its staff.

With his concept of the CSIR as a small 'corps d'elite' of creative research scientists, Schonland won approval for generous leave privileges of a maximum of 42 days for middle and senior research grades. He also encouraged staff to work for higher degrees and introduced incentives in the form of time-off for study purposes, advances for tuition fees and waiving of repayment for successful study years. This paid off to the extent that many who joined the CSIR as research assistants, some straight from school, obtained higher degrees through extramural university studies.

As a corporate body, the CSIR was obliged to develop its own administrative and management services and Schonland was directly involved in this aspect of the planning and development of the CSIR. Before the formal establishment of the CSIR he was assisted by Mr L A W Skinner, an assistant secretary in the Department of Reconstruction who had been seconded to his staff to draw up salary scales, staff regulations and conditions of service, and provide accounting and registry services. The key post of secretary/treasurer at a salary equivalent to that of a director of a CSIR institute was one of the first to be advertised by the new institution. To this post the council appointed Mr J R Sorrie, former secretary of the Royal Automobile Club of South Africa, while Mr Skinner was transferred from the Public Service to the CSIR as chief administrative officer. The secretary/treasurer in those early days had to formulate procedures in terms of the Act and provide secretarial services not only for the council itself but also for its numerous committees concerned with the development of new activities, such as the financial support of university research in science and engineering, medical research, the establishment and incorporation of research associations as non-profit companies and related activities. Mr Skinner



Mr J R Sorrie
Secretary Treasurer 1945-1955

became responsible for staff administration and related matters, while Mr K A Lewis, as assistant secretary/treasurer handled accounting and financial services. In general the object was to facilitate the provision of services required by the research staff.

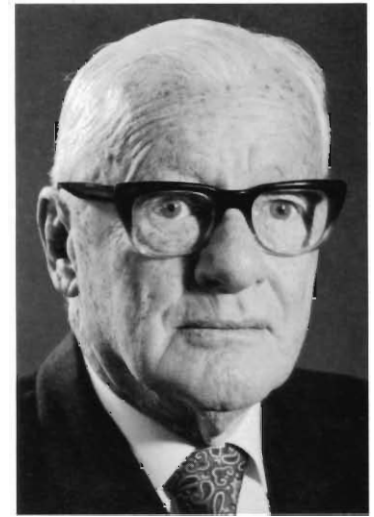
At first, these administrative and financial services were to a great extent centralized. As the CSIR developed and the organization became larger and more complex, heavier demands were being made on the staff concerned. Unfortunately at this stage the CSIR appeared to have lost sight of the dependence of the research staff on an efficient administration and in the late 1950s adopted salary scales which were more heavily differentiated to the disadvantage of the administrative staff.

In 1955 Mr Sorrie resigned and was succeeded by Mr A J Miller-Smit, secretary of the South African Bureau of Standards. In 1956, following the amalgamation of the CSIR and the SABS, Mr J H Visagie, formerly of the SABS, was appointed assistant secretary/treasurer. When these two bodies again became separate organizations in 1962, Mr Miller-Smit and Mr Visagie elected to remain with the CSIR.

The 1960s saw gradual but significant changes in the structure of the CSIR's administrative services. Responsibility for its extensive building programme and site services was transferred from the central administration to a separate Estates Department which reported directly to the office of the president. Central stores and transport services were consolidated under a new Technical Services Department based on the Central Workshops. The central administrative services separated from the CSIR executive (as the office of the president and vice-presidents came to be known) and were reorganized in an Administrative Services Department. University and medical research grants were transferred to the Information and Research Services. When Mr Miller-Smit retired in 1963 he was succeeded as secretary/treasurer by Mr Visagie with Mr A E Makin as under-secretary/treasurer (finance) until his untimely death in 1973. On the death of Mr Visagie in 1975, Mr J D van Zyl was appointed secretary/treasurer and Mr H J Bruwer assistant secretary (general administration). (The designation of secretary/treasurer was later changed to 'secretary of the CSIR' and eventually to chief director, administrative services).

From its inception the CSIR used the services of legal firms in dealing with matters such as patents, registration of non-profit companies and other legal matters. In 1956 the council decided to appoint Mrs K R Bresler, formerly of the SABS, as its own internal legal adviser. In 1967 the CSIR also appointed a security adviser. Attached to the office of the secretary/treasurer as a 'special projects officer', Mr G Abraham (formerly statistician of the SABS) played a key role in the establishment of the Associated Institutions Pension Fund (to replace the University Teachers' Provident Fund), the Statutory Organizations Medical Scheme (SOMS) and a group life insurance scheme for CSIR staff. These schemes greatly improved the benefits available to CSIR staff.

This period was marked by progressive decentralization of administrative services with the introduction of the concept of 'institute secretaries', each with an institute accountant, personnel officer and supporting staff. Finan-



Mr A J Miller-Smit
Secretary/Treasurer 1955-1963



Mr J H Visagie
Secretary/Treasurer 1964-1975



Mr J D van Zyl
Secretary/Treasurer (later Director,
Administrative Services
Department), from 1975
(Chief Director from 1983)



The Administrative Services
Department building

cial authorities were also delegated to the research institutes, eventually to the extent that they were authorized to switch funds from project to project as well as from capital to running expenses and vice versa with the approval of the executive. Back-up was provided by central staff and financial management services, while computerized systems for staff records and financial data furnished quick and accurate feedback. Decentralization was facilitated by the establishment of a Central Internal Audit Division in 1957 to check the financial operations and procedures of the CSIR institutes and by the introduction of a project budgeting system in 1962.

Decentralization

Common services in staff administration were provided by a Personnel Affairs Group under Mr C von S Fourie as manager. Among the main functions of this group were training, benefits, salary administration, recruitment, pregraduate bursaries* and staff counselling (with occupational health added in the 1970s). A central work study group was also set up to evaluate posts for administrative staff.

Personnel

Over the years, the CSIR's autonomy and much-prized 'freedom of action' was eroded to some extent, particularly in respect of salary structures – a consequence of dependence on the State for some 60 per cent of its funding. This had an inhibiting effect as research ability in science and technology is an international commodity for which there is keen competition, and there is little place for anything less than excellence in an organization such as the CSIR.

In retrospect, however, it can be argued that, although the CSIR did not enjoy the full advantages of its autonomy as a statutory body in respect of its salary structure, it did retain a measure of flexibility as regards the appointment, advancement and retrenchment of staff. Above all, as a self-contained body, it could respond quickly to changing needs in fast-moving situations.

* Whereas before 1945 there was a dearth of career opportunities for graduates in science, mathematics and engineering, the rapid technological development of the country during the 1950s resulted in a complete turn-around and in the 1960s the CSIR was relying increasingly on recruitment from European countries to fill specialized posts in its rapidly developing research institutes. To alleviate this situation, the CSIR obtained funds for the introduction of a pregraduate bursary scheme, subject to the limitation that these bursars were 'tied' to employment at the CSIR.

Diagram 1:
CSIR expenditure
1945/46 – 1984/85

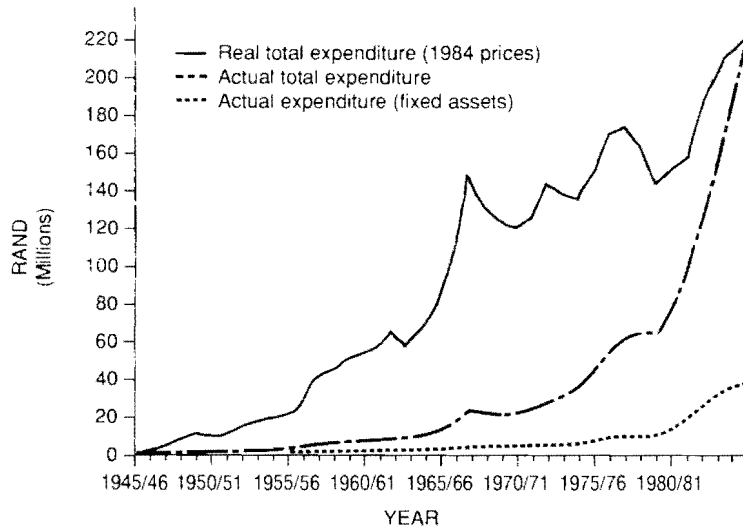
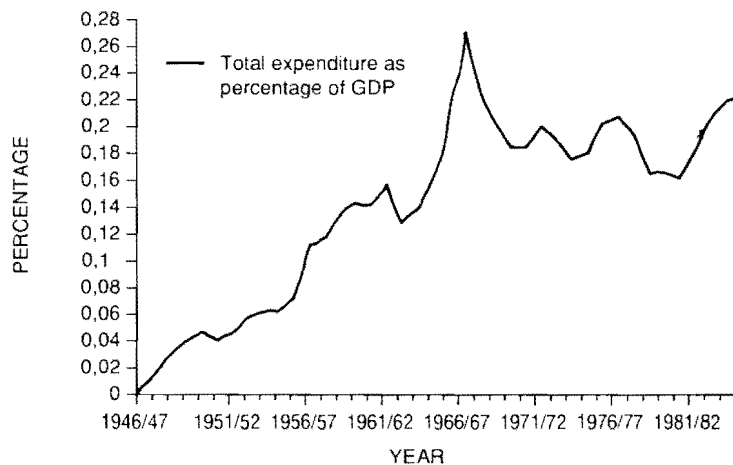


Diagram 2:
Relationship of total
expenditure to GDP
1945–1984



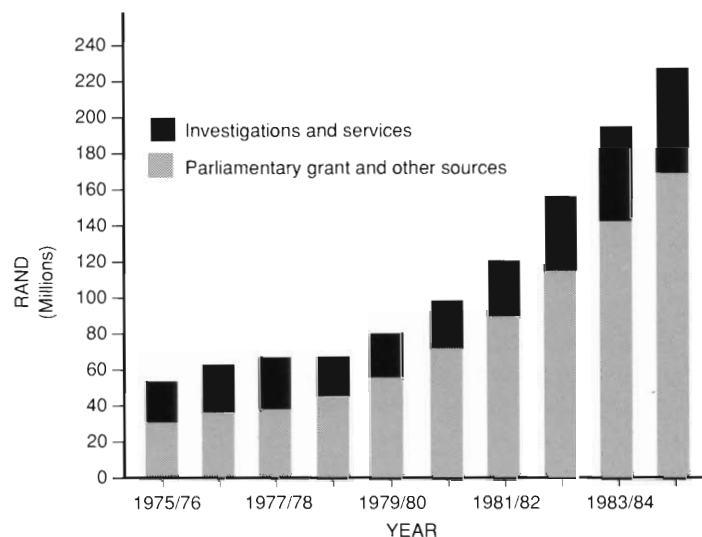
From the outset the CSIR's accounts were subject to audit by the Controller and Auditor-General, but budget control was exercised internally. As the CSIR became larger and more complex during the 1960s, responsibility for financial matters was concentrated under a financial manager, Mr J H van As.

The total investment in the CSIR over the period 1945–1985 amounted to R1 139 million. *Diagram 1* (CSIR Annual Report 1985, p. 14) reflects that a considerable proportion of this expenditure was on fixed assets, mainly in the form of sophisticated scientific equipment. The diagram also dramatically reflects the alarming effects of inflation. On the other hand, *Diagram 2* (CSIR Annual Report 1985, p. 14) indicates that after 1966 total expenditure by the CSIR levelled off at about 0,21 per cent of the gross domestic product. In other words, the rate of growth of the CSIR kept pace with the development of the economy.

The growth pattern was relatively steady until 1956 after which there were fluctuations due to the periodic incorporation of other organizations such as the Astronomical Observatory, the splitting off of organizations, very small increases in parliamentary grants in some years, and fluctuations in contract income. The further increase in the expenditure after 1980 was chiefly due

Finance

Diagram 3:
Actual total income
1975/76 – 1984/85



to the development of the National Accelerator Centre, and the incorporation of the Fuel Research Institute as the National Institute for Coal Research, and the Southern Universities Nuclear Institute (see *Diagram 1* – CSIR Annual Report 1985, p. 14).

In the financial year 1984/85 the total income of the CSIR amounted to R220 000 000 of which the parliamentary grant constituted 68,5 per cent, the balance coming from investigations and services under contract to many and varied organizations in public and private sectors (see *Diagram 3* – CSIR Annual Report 1985, p. 14). From the beginning a substantial proportion of the CSIR's funds – on average about nine per cent of running expenses – was allocated for the support of research at universities and other research organizations and for the development of scientific and technological manpower. The largest part of CSIR expenditure (some 65 per cent, on average) was absorbed by staff remuneration.

These statistics give some idea of the magnitude of the tasks with which the administrative staff had to contend in the early period of rapid build-up of the CSIR and the later period of consolidation in increasingly difficult financial circumstances brought about by inflation. As may be imagined, the financial management of income and expenditure of this order, while keeping overheads to a minimum and simplifying the task of research managers and leaders of project teams, required ingenuity, expertise and dedication.

As was pointed out in Part 1, the emergence of large research organizations and contract research were relatively recent phenomena when the CSIR was being set up. The development of expertise in research management at all levels must therefore be regarded as a major contribution of the CSIR.

The success achieved by the CSIR provided a model for the development of other research councils in South Africa, such as the Atomic Energy Board, the Medical Research Council and the Human Sciences Research Council. In retrospect, it can be argued that for these 'research councils' the 'statutory body' as a form of organization served the purpose reasonably well. The

Scientific Research Council Act of 1945 (Act 33 of 1945) was amended several times* to meet practical requirements and by 1985 the CSIR had the discretionary financial powers required to operate with the flexibility appropriate to the effective running of a contract research organization. The main inhibiting factor was the prescriptive stance of the Government in regard to salary structures, as applied by the Commission for Administration of the Public Service.

BUILDINGS AND SITE SERVICES

When the CSIR was being established in 1945, provision was made for its temporary accommodation in part of a building complex adjacent to the South African Mint in Visagie Street, Pretoria. These buildings, which had housed the Munitions Section of the Mint during the Second World War, were rented from the Public Works Department. Those occupied by the CSIR comprised two three-storey office blocks, a small single-storey building and an adjoining factory-type shell.

This accommodation was far from ideal and could be modified to a limited extent only to meet the more immediate needs for laboratory accommodation. Inadequate and unsuitable though the Visagie Street accommodation undoubtedly was, it nevertheless served a most useful purpose in providing an opportunity for the laboratories to set up their basic organization, to appoint and train staff and to plan their long-term accommodation requirements. Among the staff crowded together and working in close proximity in make-shift laboratories there was a spirit of camaraderie and a stimulating atmosphere which encouraged both rivalry and joint endeavour.

However, the need for a site to provide a permanent home for the CSIR became increasingly urgent. The Prime Minister, General Smuts, directed that the permanent home of the CSIR should be in Pretoria. Schonland favoured Johannesburg, where the industries most likely to use the services of the new research organization were concentrated. As a compromise he sought a site to the south of Pretoria, with easy access to the old Main Road between Pretoria and Johannesburg. Several sites were considered. The problem was resolved when the University of Pretoria offered a site of some 100 hectares which was due to be cut off from the eastern end of the university's experimental farm by the planned new highway to the North. Not only would this meet the requirement of easy access to the industrial areas to the south and east of Pretoria, but also had the advantage of proximity to the main residential areas. This magnificent site was made over to the CSIR in 1948 as a free gift. In the 1950s additional land to the south east was bought to make a total area of some 170 hectares. The complex was soon to become known as Scientia.

From the outset every effort was made to preserve and enhance the natural features of the main site, Scientia. Once the parkland campus lay-out had

* Act 37 of 1949	Act 60 of 1977
Act 25 of 1951	Act 59 of 1979
Act 32 of 1962	Act 31 of 1983
Act 71 of 1964	Act 64 of 1984
Act 21 of 1969	Act 82 of 1984
Act 38 of 1976	

Temporary accommodation



Mr D J J Bisschoff
Head, Estates Division, 1953-1964



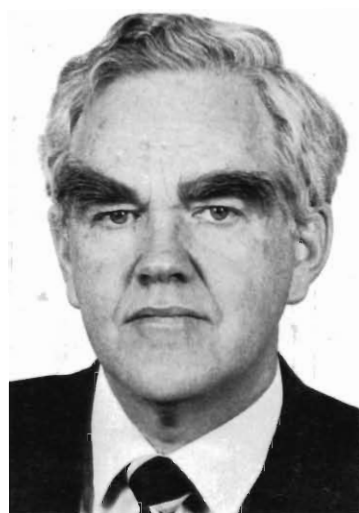
Mr A Krüger
Manager, Estates Services
Department, 1968-1981

been decided upon, Mrs Sophie Burg, landscape architect, drew up a master plan for the development of gardens and features between the proposed buildings. Under her guidance, Mr P Botha, who had joined the CSIR security and cleaning staff in 1948, played a prominent part in implementing the master plan as head of gardening services.

A nursery was developed for cultivating the trees, shrubs and flowers required for this purpose – some 30 000 plants in all. Portions of the rocky ridge between the north and south sections of the main site where 135 indigenous plant species were identified, were preserved as a nature reserve. Over the years the existing fauna, to which were added some small antelope and tortoises, increased in number.

Planning could now begin in earnest. The CSIR set up a buildings committee to gather information on the requirements of the national laboratories and institutes and appointed Burg, Lodge and Burg as consulting architects. The Council decided to adopt a parkland layout, with separate buildings for the major national laboratories and institutes as opposed to a centralized complex. This was a decision with far-reaching implications, but there is no doubt that, in the short to medium term, it contributed greatly to flexibility in the development of the site. Priority was given to special purpose buildings, for example for the cyclotron and acoustics laboratories of the National Physical Laboratory and the low-speed wind tunnel for the Mechanical Engineering Research Unit.

Estates Department



Mr G W Donaldson
Director, Estates Services
Department, from 1981
(Chief Director from 1983)

An Estates Division under Mr D J J Bisschoff was responsible for all administrative matters relating to the building programme, the co-ordination of the activities of the architects and contractors, the maintenance of completed buildings, the provision of essential services, supervision and control of caretakers, cleaners and night watchmen, and planning and layout of gardens. Another 'domestic service' was the laundry which, starting from small beginnings for the laundering of protective clothing, was eventually washing 7 750 white laboratory coats and 1 100 towels a week, as well as table linen for use in the Conference Centre and visitors' dining room.

In 1964, an Estates Department was formed incorporating certain technical functions formerly provided by the Technical Services Department. Mr A Krüger was head of the Estates Department for 12 years until his death in 1981, when Mr G W Donaldson, Assistant Director of the NBRI, was appointed Director of the Estates Department.

This appointment reflected the extent to which the buildings and site services had become a major professional activity at the CSIR. At that stage there were some 27 buildings on the main site with a similar number in various other parts of the country. The total insurable value was about R300 million and the useable floor space amounted to some 80 000 m² requiring a staff of about 200 cleaners.

Catering Services

As the main site developed, so did the need for catering services, particularly to provide lunches for staff and visitors. In response to representations from the Staff Association in the late 1960s, a working group was set up which recommended the central processing of quick-frozen meals to be



Preparing meals in bulk for freeze-drying and storage in the central processing kitchen of the Estates Department.

dispensed to the various buildings on the site. At that time the National Building Research Institute was investigating catering services for hospitals and it was decided to run a trial in the preparation and dispensing of quick-frozen meals. Based on this experiment a catering service was introduced and by the 1980s, 700 meals a day comprising 2 900 portions prepared from 280 kg of materials were being provided by the Estates Department.

Safety requirements on a site such as Scientia, where activities ranged from heavy mechanical testing to microbiology and the handling of hazardous chemicals, impose special problems. Under these circumstances absolute safety standards have to be maintained and this became the responsibility of the Safety Section of the Estates Department.

A related requirement was the maintenance of security for 24 hours a day, and this became the responsibility of the Security Section of the Estates Department with a staff of 150. Its functions included the control of visitors and the night-time surveillance of buildings and equipment.

In 1982 the name of the Department was changed to Estates Services Department and by 1985 the infrastructure included electricity supply (8 MW), water supply and reticulation (18 Ml per day), sewerage, storm water drainage and roads. The department was also responsible for the acquisition and operation of a telephone exchange with 1 750 extensions. New works continued to be a major commitment, the annual budget for which amounted to some R5,25 million. This figure included alterations and extensions to existing buildings. The Accommodation Section was responsible for establishing the needs of the scientists and translating them into their building requirements, for the planning of these new works, for the estimation of costs and for the briefing of and liaison with architects and contractors. Needless to say, they encountered many challenges in meeting the need for special purpose buildings with unusual features, such as a vibration-free laboratory for precise measuring standards, the observing station of the South African Astronomical Observatory at Sutherland, the National Accelerator Centre at Faure, and the CSIR Conference Centre.

The extent and scope of the building programme is reflected in Appendix 2.

Safety and security

*Special purpose
buildings*



Appendix 1

CHRONOLOGICAL INDEX

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<i>Date</i>		<i>Page</i>
1955	Telecommunications Research Laboratory becomes a national institute (NITR) Director: Dr F J Hewitt	175
1955	Establishment of National Institute for Road Research (NIRR) Director: Dr P J Rigden	248
1955	J E Jennings resigns and Dr N Stutterheim appointed director of the NBRI	237
1955	Establishment of National Mechanical Engineering Research Institute (NMERI) Director: Dr A J A Roux	160
1955	Dr E J Marais appointed director of the NPL	125
1955	J R Sorrie resigns and A J Miller-Smit appointed secretary/ treasurer	283
1955	E O Garnett resigns and J van der Staaij appointed head, Central Workshops	274
1955	R C Palmer resigns and Dr C C Kritzinger appointed director, SAWTRI	223
1956	NPL's Cyclotron formally commissioned	144
1956	Amalgamation of S A Bureau of Standards and CSIR	23
1957	NPL renamed National Physical Research Laboratory (NPRL)	127
1957	E W Dohse, vice-president, retires	24
1957	Dr A J A Roux appointed a vice-president responsible for drafting an atomic energy research programme	22
1957	Dr W L Grant appointed director of NMERI	22
1957	Establishment of scientific liaison office in Cologne, West Germany Head: Dr J P van Zyl	57
1957	Dr A W Lategan appointed director, SABS	23
1957	Dr F W Quass appointed director, NNRI	206
1958	Dr W S Rapson appointed a vice-president	24
1958	Dr P C Carman appointed director, NCRL	202
1958	Establishment of National Institute for Water Research (NIWR) Director: Dr G J Stander	213
1958	Liaison Division and Library and Information Division combined to form Information and Special Services Department (ISSD) Head: D G Kingwill	107

<i>Date</i>		<i>Page</i>
1958	Formation of Technical Services Department (TSD) combining Central Workshops and other technical services Head: J van der Staaij	275
1953	Establishment of Estates Division Head: D J J Bisschoff	288
1958	Establishment of the Administrative Services Department Secretary/treasurer: A J Miller-Smit	283
1959	Dr A J A Roux resigns	160
1959	Dr N Stutterheim appointed a vice-president	24
1959	Dr T L Webb appointed director, NBRI	
1959	Dr W L Grant resigns and Dr H G Denkhaus becomes director, NMERI, the following year	160
1960	Formation of Timber Research Unit (TRU) Head: Dr D L Bosman	230
1960	Formation of Air Pollution Research Group (APRG) Head: Dr E C Halliday	133
1961	Establishment of National Research Institute for Mathematical Sciences (NRIMS) Director: Dr A P Burger	147
1961	Establishment of Radio Space Research Station at Hartebeesthoek under the NITR	182
1961	Establishment of Microbiology Research Group Head: Dr J P van der Walt	209
1962	SABS and CSIR become separate organizations	24
1962	Formation of Corrosion Group under Dr C E Bird	194
1962	Establishment of S A Inventions Development Corporation (SAIDCOR) Manager: A M Schady	102
1962	Dr W S Rapson resigns	25
1962	Dr E J Marais appointed a vice-president	25
1962	Dr A Strasheim becomes director, NPRL	125
1962	Prof. L J le Roux appointed vice-president, Defence Research	25
1962	Dr S Biesheuvel resigns and Mr D J Gouws appointed director of the National Institute for Personnel Research	262
1962	D G Kingwill appointed director of Information and Research Services (IRS)	107

<i>Date</i>		<i>Page</i>
1962	Formation of Sorghum Beer Research Unit Head: Dr L Novellie	195, 211
1963	Establishment of National Institute for Rocket Research and Development Director: Dr J P A Lochner	167
1963	J van der Staaij promoted director, Technical Services Department	275
1963	A J Miller-Smit retires as secretary/treasurer and J H Visagie appointed in his place the following year	283
1964	Dr E J Marais resigns	25
1964	Dr F J Hewitt appointed vice-president	25
1964	R W Vice appointed director, NITR	25
1964	Republic Observatory incorporated into CSIR	186
1964	SAWTRI incorporated into CSIR. Dr C C Kritzingers resigns and Dr D P Veldsman appointed director	224
1964	Government Mechanical Laboratory incorporated into CSIR to form Mining Equipment Research Unit under NMERI	165
1965	Dr W H Craib appointed vice-president for medical research	26
1965	Dr F W Quass resigns and Dr J J Theron appointed director of NNRI	209
1965	Prof. L J le Roux resigns	25
1965	Establishment of National Institute for Defence Research (NIDR) incorporating the National Institute for Rocket Research and Development Director: Dr T J Hugo	25
1965	Dr D J Gouws resigns and is succeeded by D J M Vorster as director of the NIPR	262
1965	Estates Department established (formerly Estates Division)	288
1966	Dr K Douwes-Dekker retires and Dr M Matic becomes director of SMRI	93
1967	Dr N Stutterheim appointed deputy president (a new post)	24
1967	Dr W H Craib retires	26
1968	Dr C van der M Brink appointed a vice-president	31
1968	A Krüger appointed manager of Estates Services Department	288
1968	Establishment of Scientific Liaison Office in Paris Head: O A van der Westhuysen	56

<i>Date</i>		<i>Page</i>
1969	CSIR's medical research activity transferred to new Medical Research Council	54
1969	Dr J J Theron appointed vice-president and chief executive officer of the Medical Research Council	209
1969	Establishment of National Food Research Institute (NFRI) J P de Wit appointed director	209
1969	Dr N Stutterheim resigns	27
1969	Hydraulics Research Unit of NMERI transferred to Stellenbosch	161
1969	Oceanographic research vessel <i>Meiring Naudé</i> commissioned in Durban (launched in 1967)	169
1969	Magnetic Observatory, Hermanus, incorporated into CSIR with A M van Wijk as head	190
1970	Dr C van der M Brink appointed deputy president	31
1970	Dr P J Rigden appointed vice-president	27
1970	Dr S H Kühn appointed director, NIRR	250
1970	Dr G M Dreosti retires and Dr R J Nachenius becomes director, FIRI	91
1971	Dr S M Naudé retires	31
1971	Dr C van der Merwe Brink appointed president	31
1971	Dr J F Kemp appointed a vice-president	27
1971	SAWTRI renamed S A Wool and Textile Research Institute (national institute for all textile fibres)	225
1971	Establishment of National Electrical Engineering Research Institute (NEERI) Director: J D N van Wyk	153
1971	Dr G J Stander resigns and Dr G G Cillié appointed director, NIWR	221
1971	G M Hamilton retires and Prof. D W S Evans appointed director, SAPRI	94
1972	Dr F J Hewitt appointed deputy president	31
1972	Dr P C Carman retires and Dr P R Enslin appointed director, NCRL, the following year	202
1972	Establishment of S A Astronomical Observatory (SAAO)	187
1972	J van der Staaij retires and Dr T Hodgson appointed director, of TSD the following year	280

<i>Date</i>		<i>Page</i>
1973	Sir Richard van der Riet Woolley appointed director, SAAO	187
1973	Dr A P Burger appointed a vice-president	33
1973	Prof. C Jacobsz appointed director, NRIMS	147
1973	Agreement with Centre National d'Etudes Spatiales (CNES) for operation of French tracking station, Paardefontein	184
1973	Prof. D W S Evans resigns and Dr D A Williams-Wynn appointed director, SAPRI	94
1973	Chemical Engineering Research Group (CERG) becomes an independent entity separate from NCRL Head: W G B Mandersloot	203
1974	Establishment of National Research Institute for Oceanology (NRIO) Director: Prof. E S W Simpson	170
1974	Dr S G Shuttleworth retires and Dr D R Cooper appointed director, LIRI, the following year	88
1975	SAPRI closed	94
1975	J D van Zyl appointed secretary/treasurer on death of J H Visagie	283
1975	Prof. D H Jacobson appointed director, NRIMS, after retirement of Prof. C Jacobsz	147
1975	Establishment of scientific liaison office in Teheran Head: G A Harvey	56
1975	Co-operative Scientific Programmes (CSP) becomes separate unit	73
1975	Formation of Centre for Scientific and Technical Information (CSTI) under IRS Head: Dr R van Houten	115
1975	Formation of Production Engineering Advisory Service (PEAS) under TSD Head: Dr T Hodgson	280
1976	NIRR becomes National Institute for Transport and Road Research (NITRR) Director: Dr S H Kühn	251
1976	Timber Research Unit becomes National Timber Research Institute (NTRI) Director: Dr D L Bosman	230
1976	Dr E S W Simpson resigns and F P Anderson becomes director, NRIO	170
1976	Sir Richard van der Riet Woolley retires as director of the SAAO and succeeded by Dr M W Feast	189
1977	Dr A P Burger resigns	33

<i>Date</i>		<i>Page</i>
1977	Dr D M Joubert appointed a vice-president	33
1977	Establishment of National Accelerator Centre (NAC) Director: Dr G Heymann	146
1977	Dr G K Nelson appointed director of the NIPR on the retirement of D J M Vorster	273
1977	Commissioning of CSIR Conference Centre	118
1977	Dr G J Kühn appointed head of the Magnetic Observatory, Hermanus, following the retirement of A M van Wijk	190
1978	Establishment of National Institute for Aeronautics and Systems Technology (NIAST) Director: Dr T J Hugo	161
1978	Establishment of Satellite Remote Sensing Centre at Hartebeesthoek under NITR	182
1978	Establishment of Radio Astronomy Observatory at Hartebeesthoek under Dr G D Nicolson, NITR	185
1978	Dr D M Joubert resigns	37
1979	Dr C F Garbers appointed a vice-president	37
1979	Dr P J Rigden retires	36
1979	J P de Wit appointed a vice-president	37
1979	Dr L Novellie appointed director, NFRI	210
1979	Dr D P Veldsman resigns as director of SAWTRI and succeeded by Dr D W F Turpie	226
1979	Dr R J Nachenius retires and Dr J P H Wessels appointed acting director, FIRI	91
1979	Dr M Matic retires and Dr A B Ravnö appointed director, SMRI	93
1979	Centre for Computing Services (CCS) becomes a separate Institute Dr E N van Deventer appointed director	152
1980	Dr F J Hewitt retires	37
1980	Dr C F Garbers appointed deputy president	37
1980	Death of Dr C van der M Brink	36
1980	Dr C F Garbers appointed president	37
1980	Dr J F Kemp appointed deputy president	37
1980	Dr E N van Deventer appointed a vice-president	37
1980	V A Shaw appointed director, CCS	38, 152

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1980	Prof. D H Jacobson appointed a vice-president	37, 147
1980	Dr D H Martin appointed director, NRIMS	38, 147
1980	Dr G Heymann appointed a vice-president	37
1980	Dr D Reitmann appointed director, NAC	38
1980	CSTI becomes a separate national institute Director: Dr R van Houten	36, 115
1980	CSIR becomes responsible for Fuel Research Institute	236
1980	Establishment of National Calibration Service (NCS) within the framework of the NPRL	131
1980	Dr T L Webb retires and J F van Straaten appointed director, NBRI	38, 238
1980	Establishment of Scientific Liaison Office, Los Angeles Head: N C Hauffe	56 ,
1980	Dr H G Denkhaus retires and Dr M S Hunt appointed director, NMERI, the following year	38
1981	Dr R R Arndt appointed a vice-president	37
1981	G W Donaldson appointed director of Estates Services Department on the death of A Krüger	288
1981	Dr J P H Wessels appointed director, FIRI, on retirement of Dr R J Nachenius	91
1982	Dr A Strasheim retires and Dr J S V van Zijl appointed director, NPRL, the following year	39
1982	A M Schady retires as manager of Saidcor and succeeded by A A de Waal	38, 106
1982	D G Kingwill retires	40
1983	Establishment of Laboratory for Molecular and Cell Biology Director: Dr J A Thompson	83
1983	Establishment of National Institute for Materials Research (NIMR) Chief director: Dr J B Clark	140
1983	Dr P R Enslin retires as director, NCRL, and followed by Dr J R Bull as chief director	39, 202
1983	D G Kingwill appointed acting director, IRS	40
1984	Fuel Research Institute incorporated into CSIR in terms of Act of Parliament and renamed National Institute for Coal Research (NICR) Chief director: Dr T C Erasmus	39, 236

<i>Date</i>		<i>Page</i>
1984	Dr L R P Butler appointed chief director, IRS	40
1984	Dr G G Cillié retires as chief director, NIWR, and followed by Dr D F Toerien	39
1984	Dr J Morris appointed chief director, NBRI, on retirement of J F van Straaten	40
1984	Dr R van Houten retires. CSTI and CCS combine to form National Institute for Informatics Chief director: V A Shaw	40
1984	Establishment of Foundation for Research Development (FRD) under Dr R R Arndt, vice-president	39, 73
1984	Dr D L Bosman resigns and Dr A Pizzi appointed director, National Timber Research Institute	233
1984	PEAS transferred from Technical Services Department to National Mechanical Engineering Research Institute Head: Dr T Hodgson	281
1984	P Lasserre appointed chief director, Technical Services Department	040, 281

Appendix 2

BUILDING PROGRAMME ON SCIENTIA CAMPUS, PRETORIA

Date of completion	Building	Extension dates	Original cost (R)	Replacement value (R)
1952	NMERI Wind Tunnel No. 1	1969/79	679 000	2 652 000
1954	NBRI	1969/73/76	1 441 600	5 910 000
1954	NPRL Acoustics Bldg	1976/82	237 200	795 000
1955	NPRL Cyclotron Bldg	1973	594 000	3 620 000
1955	NPRL Biophysics Bldg	1984	1 180 000	1 780 000
1955	TSD Central W/shops	1973/76	527 800	1 780 000
1956	CSIR Library/CSTI Bldg	1966/71/75	617 000	5 530 000
1957	Exec. & Admin. Bldg	1968	488 000	3 333 000
1957	Estate Manager's House		10 800	70 000
1957	NPRL Main Building	1968/75/76	1 626 300	6 890 000
1957	NMERI Main Building		390 000	2 950 000
1958	NIWR	1965/76/77	888 000	3 560 000
1959	NIFR	1968/72/79	757 000	3 788 000
1960	NCRL	1976	1 056 000	4 924 000
1962	TSD Main Bldg	1966/68/72/76/83	908 000	3 825 000
1962	NMERI Hydro Bldg		137 600	1 060 000
1963	NMERI Thermo Bldg		396 000	2 120 000
1963	NRIMS	1982	1 428 000	3 560 000
1963	NICER	1973/74	496 000	2 500 000
1964	NITRR	1977	1 300 000	3 410 000
1969	NIASST	1973/74/76	1 728 000	6 820 000
1972	NPRL Air Pol. Res. Bldg	1976	283 000	1 212 000
1973	ESD Main Bldg	1974	200 000	674 000
1973	NIPR		200 000	758 000
1975	ESD Prod. Kitchen		388 000	947 000
1976	NEERI	1979/81	5 370 000	8 258 000
1976	Computer Centre		1 117 000	2 650 000
1977	Conference Centre		3 000 000	6 820 000
1977	TSD Transport Depot		380 000	886 000
1977	NMERI Wind Tunnel No.2		417 000	947 000
1979	Multipurpose (NIMR)	1982	1 700 000	3 788 000
1981	NTRI		2 400 000	3 674 000
1982	TSD Printed Circuits Bldg		1 450 000	1 894 000
1983	IRS Visitors' Reception		635 000	750 000
1984	Emfuleni Flats (purchase)		1 192 000	1 970 000

CSIR BUILDINGS OUTSIDE PRETORIA UNTIL DECEMBER 1985

Building	Date of completion	Extension dates	Original cost (R)	Replacement cost (R)
Natal Regional Laboratory	1960	1972/73	790 000	4 600 000
NIPR*	1961	1983	261 800	2 085 200
MERU (Jhb) (Addition)	1965		122 000	774 000
NITR (Main Building)	1965	1975/76	680 000	2 400 000
SAWTRI (Port Elizabeth)	1969	1974/77 1984	4 430 000	12 500 000
Magnetic Observatory (Hermanus)	1969	1972/84	162 000	800 000
NRIO New Block	1970 1984	1975/79	992 000 5 400 000	3 000 000 6 800 000
SAAO Sutherland Complex	1972	1975/84	2 150 000	6 500 000
Hartebeesthoek (Taken over from NASA)	1975			4 400 000
NAC (Main Buildings)	1984		23 700 000	45 500 000

* Transferred to Human Sciences Research Council in 1985.

Appendix 3

BIOGRAPHICAL NOTES

MEMBERS OF FIRST COUNCIL, DIRECTORS OF LABORATORIES AND INSTITUTES AND HEADS OF GROUPS AND UNITS

Mr F P Anderson

Mr Anderson was appointed director of the National Research Institute for Oceanology (NRIO) in 1976. (In 1983 the designation of this post was changed to chief director.)

Frank Porter Anderson was born in Bonnievale in 1927. After serving in the Technical Corps during the Second World War he graduated from the University of Cape Town with an MSc in physics in 1950. He joined the CSIR in 1951 and was sent for training in oceanography to the Department of Operational Research of the Royal Navy and the National Institute for Oceanography in Surrey, England. On his return to South Africa in 1954 he was appointed head of the CSIR's Marine Research Unit in Cape Town. In 1960 he became head of the Oceanography Division of the National Physical Research Laboratory in Durban. When the National Research Institute for Oceanology was founded in 1974, he became assistant director in charge of its east coast branch. In 1976 he was appointed director.

Dr R R Arndt

Dr Arndt was appointed to the CSIR executive in 1981 as a vice-president, a designation changed to deputy president in 1983, and from 1984 was responsible for the Foundation for Research Development.

Reinhard Richard Arndt was born in Bloemfontein in 1929. He studied at the University of the Orange Free State where he obtained an MSc in 1953 and a DSc in 1959. Subsequently he obtained an MBA from the University of Pretoria.

After working for a short while for the South African Bureau of Standards, he joined the CSIR's National Chemical Research Laboratory in 1955 and became the leader of a group doing research on the flora of South Africa as a source of pharmaceutically useful compounds. In 1967 he was appointed professor at the Rand Afrikaans University and in 1969 became professor of organic chemistry at the University of Stellenbosch. Dr Arndt worked abroad as a postdoctoral bursar at the National Research Council in Canada (1959/1960) and as a research fellow at the University of Stanford, California (1964/1965). He was visiting professor at the ETH in Zürich on an Ernest Oppenheimer Memorial Trust Bursary (1972/1973) and was invited to Cambridge University as visiting professor in 1978.

He was a president of the South African Chemical Institute.

Professor S Biesheuvel

Professor Biesheuvel was the first director of the National Institute for Personnel Research, a position he held from 1948 until 1962.

Simon Biesheuvel was born in 1908 in Rotterdam, Netherlands. His father's work for a firm with international interests took the family to various countries and finally, in 1922, to South Africa. He studied at the University of Cape Town where he obtained an MA degree in psychology in 1930. He then studied at the University of Edinburgh, Scotland, on a Webb Gift Research Scholarship, and received a PhD in psychology in 1933.

On his return to South Africa he was a lecturer at the University of Stellenbosch, a laboratory assistant and tutor at the University of Cape Town and then a lecturer in psychology at the

University of the Witwatersrand. In 1940, he joined the South African Air Force as head of the Aptitude Test Section and was demobilized in 1946 with the rank of Acting Lieutenant-Colonel.

He accepted an appointment to set up a National Bureau for Personnel Research under the CSIR. In 1948 the bureau became the CSIR's National Institute for Personnel Research with Dr Biesheuvel as its director. In 1962 he resigned to become an executive director responsible for the personnel function of the South African Breweries organization. When he retired in 1973 he became head of the University of the Witwatersrand's Postgraduate School of Business and professor of business administration. On his retirement from this post in 1977 he was appointed honorary professorial research fellow.

Dr Biesheuvel was a member of numerous learned and professional societies, many of which conferred on him honorary memberships and fellowships. He was a president of the SA Association for the Advancement of Science and was awarded honorary doctorates by the University of Natal and the University of the Witwatersrand.

Mr D J J Bisschoff

Mr Bisschoff was appointed secretary of the CSIR's building committee in 1953 with the designation officer-in-charge of the Estates Division.

Daniel Jacobus Johannes Bisschoff was born in 1923. He studied commercial art and afterwards freelanced until he joined Enamel Products Ltd in 1948 as designer and later production manager. In 1951 he took up a post in the Department of Public Works before being appointed officer-in-charge of the Estates Division (later Estates Department) of the CSIR responsible for the development of the Scientia site. He resigned in 1964 to run his own building enterprise.

Dr D L Bosman

Dr Bosman became the first director of the National Timber Research Institute (NTRI) in 1976, a post he held until 1984. (In 1983 the designation was changed to chief director.)

Danfël Lowne Bosman was born in 1928 in Swartruggens, Transvaal, and studied at the University of the Witwatersrand where he obtained an MSc in mechanical engineering in 1952. He also obtained an MBA from the University of Pretoria and a DSc (Timber Technology) from the University of Stellenbosch.

He did his practical training in engineering at Rolls-Royce Ltd in Britain. He was appointed to a research fellowship in wooden packaging in the CSIR's National Mechanical Engineering Research Institute in 1955. In 1960 he became head of the newly founded Timber Research Unit and in 1976 director of the National Timber Research Institute. When he left the NTRI in 1984 he became a full-time member of the Board of Trade and Industry.

While at the NTRI he was president of the SA Institute of Forestry, president of the Engineers' Association of SA, leader of two groups of the International Union of Forestry Research Organizations and a Fellow of the International Academy of Wood Science.

Dr C van der Merwe Brink

Dr Brink was president of the CSIR from 1971 to 1980.

Christiaan van der Merwe Brink was born in the Piketberg district 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 (Iskor).

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. He died in 1980.

Dr Brink was chairman of the Suid-Afrikaanse 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 degrees 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.

Dr O W H O Brune

Dr Brune was acting director of the National Physical Laboratory (later the National Physical Research Laboratory) from 1950 until 1952.

Otto Walter Heinrich Oscar Brune was born in Kimberley in 1901. In 1921 he received an MSc degree from Victoria College, forerunner of the University of Stellenbosch. After teaching for a year he became a lecturer in mathematics at the Transvaal University College (later the University of Pretoria) until he resumed his studies at the Massachusetts Institute of Technology in the USA. There he received an ScD for his work on network synthesis in 1931.

After four more years of research and teaching at the MIT, he returned to South Africa as an engineer with the SA General Electric Company. During the Second World War he served as a technical officer and worked on the application of radar. He joined the CSIR shortly after it was founded and contributed largely to the development of the NPRL from which he retired in 1966.

Dr Brune was a founder member and first president of the SA Council for Automation and Computation. In 1971 the University of Pretoria awarded him an honorary doctorate. He died in 1982.

Dr J R Bull

Dr Bull was appointed chief director of the National Chemical Research Laboratory (NCRL) in 1983.

James Ronald Bull was born in East London in 1937 and studied at the University of Natal where he obtained an MSc degree in organic chemistry in 1960. He continued his studies at the University of Oxford on a Commonwealth Scholarship, receiving his DPhil degree in 1964. In 1965 he worked as a postdoctoral fellow at the University of Stanford, USA.

While studying at the University of Natal, he was process chemist for Dunlop SA and later became a lecturer at the university. Dr Bull joined the National Chemical Research Laboratory in 1964 and became head of the Organic Chemistry Division in 1973 and chief director of the laboratory in 1983.

He was awarded the Gold Medal of the SA Chemical Institute in 1984. He became the editor of the *South African Journal of Chemistry* in 1972.

Dr A P Burger

Dr Burger was a vice-president of the CSIR from 1973 until 1976.

Alewyn Petrus Burger was born in Middelburg, Transvaal, in 1927. After obtaining an MSc degree in mathematics from the University of Pretoria in 1952, he studied at the Technische Hogeschool, Delft, Netherlands, and obtained a DSc in mathematics in 1955.

On his return to South Africa he did research for the SA Weather Bureau. In 1957 he joined the CSIR as head of the Applied Mathematics Section of the National Physical Research Laboratory. He became director of the newly established National Research Institute for Mathematical Sciences in 1961 and vice-president of the CSIR in 1973. He held the position of scientific adviser to the Prime Minister from 1976 to 1981.

Dr Burger was invited to co-operate on research projects in the Netherlands, Sweden and the USA. He was chairman of the SA Mathematics Society and of the science and mathematics section of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns, and president of the Joint Council of Scientific Societies. In 1973 he was awarded the Havenga Prize for Mathematics by the Suid-Afrikaanse Akademie vir Wetenskap en Kuns.

Dr L R P Butler

Dr Butler was appointed chief director of the CSIR's Information and Research Services in 1984.

Louis Robert Patrick Butler was born in Smithfield, OFS, in 1929. He obtained an Advanced Technical Diploma from the Pretoria Technical College in 1953, a BSc from the University of Pretoria in 1957, an MSc in physics from the University of Stellenbosch in 1962, a PhD in geochemistry from the University of Cape Town in 1968 and a DSc from UCT in 1980.

He worked at Iscor for almost a year before joining the CSIR's National Physical Laboratory in 1948. In 1967 he became head of the Spectroscopy Division. In 1980 he transferred to the CSIR's Co-operative Scientific Programmes and in the same year became head of the CSIR's Scientific Liaison Office attached to the SA Embassy in Bonn, West Germany. In 1983 he was appointed chief director of Information and Research Services.

During 1971/72 Dr Butler held an Alexander von Humboldt Fellowship and did postdoctoral research in Germany. In 1978 he was visiting professor at the University of Toronto, and in 1980 received the Arlabs Gold Medal from the Spectroscopic Society of South Africa.

Dr P C Carman

Dr Carman was director of the National Chemical Research Laboratory (NCRL) from 1958 until 1972.

Philip Crosbie Carman was born in Wellington, New Zealand, in 1907, where he obtained an MSc degree in chemistry and mathematics in 1930. In 1931 he did postgraduate research for which he was awarded the 1851 Exhibition Scholarship. He continued his studies at the University College, London, where he was awarded a Unilever scholarship. By 1934 he had completed a Diploma in Chemical Engineering and a PhD degree. He then joined Imperial Chemical Industries (ICI), gaining experience in industrial research. In 1936 he came to South Africa as a lecturer at the University of Cape Town and later became a senior lecturer. Dr Carman started his career at the NCRL in 1947 and became director in 1958. He held this post until his retirement.

He was a president of the SA Chemical Institute and was awarded the Institute's Gold Medal in 1971 and again in 1977, this time for the best series of papers on physical chemistry published in the institute's journal.

Dr G G Cillié

Dr Cillié was director of the National Institute for Water Research (NIWR) from 1971 until his retirement in 1984. (The designation of this post was changed to chief director in 1983.)

Gabriel Gideon Cillié was born in Wellington, Cape Province, in 1920. He obtained a BSc degree in applied and industrial chemistry in 1941 and a PhD in 1957 at the University of Cape Town.

Before joining the CSIR in 1947, Dr Cillié worked as a chemist in various industries such as the AECI in Somerset West and the National Trawling and Fishing Co. in Cape Town and later in Durban. He started his career at the CSIR as a research officer in the Liaison Division. In 1950 he joined the Water Research Division of the National Chemical Research Laboratory where he became a senior research officer. From 1955 until 1962 he was chief chemist of the Paarl Municipality and in 1963 he returned to the CSIR as head of the NIWR's regional laboratory in the Western Cape. In 1971 he was appointed director of the institute.

Dr J B Clark

Dr Clark was the first chief director of the National Institute for Materials Research (NIMR) which was founded in 1983.

James Brian Clark was born in Pretoria in 1949. After matriculating in 1965, he worked at the National Physical Research Laboratory (NPRL) while studying part-time. He obtained 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 he was also a manager of the national programme for materials science under the CSIR's

co-operative scientific programmes. In 1981 he was appointed assistant director of the NPRL and when the National Institute for Materials Research was founded in 1983 he became its first chief director.

Dr Clark did postdoctoral research at the University of Munich in 1974 as the holder of an Alexander von Humboldt Scholarship, and in 1975 he was awarded a postgraduate research grant by the Material Research Laboratory of the Pennsylvania State University. He was made an honorary professor of the University of the Witwatersrand and received the FOYSA award from the Junior Chamber of Commerce and Shell SA, the Meiring Naudé Medal from the Royal Society of South Africa and the British Association Medal from the SA Association for the Advancement of Science.

Dr D R Cooper

Dr Cooper was appointed director of the Leather Industries Research Institute (LIRI) in 1975.

Desmond Rudolph Cooper was born in Durban in 1928. He obtained an MSc degree from Rhodes University in 1952 and a PhD from the University of Cambridge in 1957.

He first worked at LIRI as a student assistant from 1949 to 1953 and again as a research officer from 1956 to 1958. After a year at the SA Institute for Medical Research, he became sales engineer for Protea Holdings in 1959 and returned to LIRI as head of the Hide, Skin and Protein Division in 1962. He was appointed deputy director in 1973 and director in 1975.

Dr Cooper was a president of the Society of Leather Trades Chemists.

Dr W H Craib

Dr Craib was the CSIR vice-president responsible for medical research from 1965 to 1967.

William Hertzog Craib was born in Somerset East in 1895. He qualified as an engineer from the University of Cape Town in 1914. After the First World War he studied medicine at Cambridge and at Guy's Hospital, London, and in 1925 was awarded a Rockefeller Fellowship for medical research at Johns Hopkins University and Medical School in the United States. Here he started his research on the sources of electricity in the human heart muscles which he continued on his return to London. He was awarded an MD from Cambridge in 1929 (only later in life was he given credit for this important work).

On his return to South Africa he entered private practice as a specialist physician, and in 1932 he became professor of medicine at the University of the Witwatersrand. During the Second World War he served as consultant in medicine to the South African Armed Forces. After the war he went into private practice in Port Elizabeth. He had already retired from this practice when he became involved in CSIR medical research.

Dr Craib was a Fellow of the Royal College of Physicians, London, and an Honorary Fellow of the College of Physicians of SA. He was elected to the Society of Scholars by Johns Hopkins University and was awarded honorary doctorates by the universities of Cape Town, the Witwatersrand, Natal, Stellenbosch and Rhodes. He died in 1982.

Dr H G Denkhäus

Dr Denkhäus was director of the National Mechanical Engineering Research Institute (NMERI) from 1960 to 1980.

Hans Günter Denkhäus was born in Duisburg, Germany, in 1920. He qualified as Diplom-Ingenieur at the Technische Hochschule Berlin-Charlottenburg in 1942 and obtained the degree of DrIng from the Technische Hochschule Braunschweig (Brunswick) in 1948. He was chief assistant to the director of the Wöhler-Institut in Brunswick from 1946 until 1949 when he became chief engineer of the Institut für Mechanische Schwingungstechnik in Karlsruhe. In 1952 he came to South Africa as head of the Materials Mechanics Division of the Mechanical Engineering Research Unit (later the NMERI). He was promoted to acting director of the NMERI in 1959 and became director of the institute the following year. After retiring from the CSIR he was appointed senior lecturer and then professor of mechanical engineering at the University of Pretoria.

Dr Denkhaus was a vice-president of the International Society for Rock Mechanics and president of the SA Institution for Mechanical Engineers. In 1981 he received the Havenga Prize for Engineering from the Suid-Afrikaanse Akademie vir Wetenskap en Kuns.

Dr F J de Villiers

Dr de Villiers was a member of the CSIR Council on which he served, with a short interruption, from 1945 to 1962.

Francois Jean de Villiers was born in Paarl in 1898 and obtained a BSc degree from the University of Cape Town in 1918. He continued his studies in the USA, obtaining an MSc from the University of California and a PhD from Cornell University. On his return to South Africa he obtained a DSc in chemistry from the University of South Africa.

He started his working career at the Elsenburg Agricultural College and later joined the chemistry section of the Department of Agriculture in Pretoria. He became industrial adviser to the Department of Commerce and Industry in 1938, a post he held for 20 years. From 1958 to 1963 he was director of industrial development in the then Department of Bantu Administration and Development.

Dr de Villiers was the author of the De Villiers Report on Technical Education in South Africa. He was also a member of the council of the University of Pretoria and later chancellor of the University of South Africa from which he received an honorary doctorate in education.

He was chairman of the Electricity Control Board, the council of the Fuel Research Institute, the council of the SA Bureau of Standards and the Defence Resources Council. He was also chairman of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns which awarded him the Havenga Prize for Chemistry and the Frans du Toit Prize for Industrial Economy. In 1965 he was elected honorary member of the akademie. Dr de Villiers was a founder and chairman of the South Africa Foundation. He died in 1980.

Mr A A de Waal

Mr de Waal was appointed manager of the SA Inventions Development Corporation (Saidcor) in 1982.

Andries Albertus de Waal was born in Pretoria in 1930. After completing an apprenticeship in aircraft construction in Gloucester, Britain, he joined the research section of Imperial Chemical Industries in London. He returned to South Africa in 1955 to work at the CSIR's National Mechanical Engineering Research Institute while studying part-time to obtain a BSc degree from the University of Pretoria. In 1964 he became responsible for the CSIR publication, *Technical Information for Industry (TI)*. The following year he joined Saidcor as a project manager and in 1982 became general manager.

Mr J P de Wit

Mr de Wit was a vice-president of the CSIR from 1979 until his retirement in 1985. (In 1983 the designation of this post was changed to deputy president.)

Born in Reitz in the Orange Free State in 1924, Johannes Petrus de Wit graduated from the University of Stellenbosch in 1944 and obtained an MSc in chemistry from the University of Pretoria in 1946. He joined the CSIR in 1949 after doing research at the Department of Agricultural Technical Services and in industry.

He was posted to the CSIR's scientific liaison office in London and became head of the office in 1951. In 1954 he returned to a research career in the Food Technology Section of the National Chemical Research Laboratory. In 1959 he became assistant director of the National Nutrition Research Institute (NNRI) and in 1969 became the first director of the newly established National Food Research Institute. He held this post until 1979 when he was appointed a vice-president of the CSIR.

He served as president of the SA Nutritional Society and the Society for Food Scientists and Technologists. In 1982 he was elected as one of the vice-presidents of the International Scientific Committee on Antarctic Research (SCAR).

Mr E W Dohse

Mr Dohse was a vice-president of the CSIR from 1952 to 1957.

Ernst Walter Dohse was born in Beaconsfield, Cape Province, in 1897, and obtained a BSc(Eng) from the University of Cape Town. He joined the Public Works Department in 1921 and became its chief engineer in 1944. During the Second World War he served with the SA Engineering Corps. After the war he became Deputy Director of Works and in 1945 was seconded to the newly established CSIR and helped to establish the National Building Research Institute, serving as director until a permanent appointment was made in 1947. He was appointed vice-president of the CSIR in 1952, a post he held until his retirement in 1957 when he became special adviser to the president of the CSIR. From 1963 until 1968 he was the building adviser to the SA Bureau of Standards. He died in 1975.

Mr G W Donaldson

Mr Donaldson was appointed director of the CSIR's Estates Services Department in 1981, a designation which was changed to chief director in 1983.

George William Donaldson was born in Malmesbury in the Cape in 1928. In 1950 he obtained a BSc(Eng) and later an MSc from the University of Cape Town. In 1951 he joined the Soil Mechanics Division of the National Building Research Institute and became head of the division in 1961 and assistant director of the institute in 1980.

Mr Donaldson was particularly active in the Geotechnical Division of the SA Institution of Civil Engineers. He was elected a Fellow of the SAICE and served on its council from 1962. He represented South Africa on several occasions on the executive committee of the International Society of Soil Mechanics and Foundation Engineering.

Dr K Douwes-Dekker

Dr Douwes-Dekker was the first director of the Sugar Milling Research Institute (SMRI) in Durban, a position he held from 1949 to 1966.

Kees Douwes-Dekker was born in Holland in 1901 and obtained a doctorate in physical chemistry in 1927. Shortly afterwards he was appointed research chemist to the Proefstation voor de Java Suikerindustrie in Pasuruan, Java, where he rose to the position of chief chemist in 1937 and director of the Technical Division in 1939. He served during the Second World War and spent the last three years as a prisoner of war in Java. In 1946 he was commissioned to make a study of the sugar industry in Formosa and on completion of this task returned to Holland where he joined the CSM Beet Sugar Factory in Steenberg as assistant manager. In 1949 he came to South Africa as director of the SMRI, a post from which he retired in 1966. He stayed on for one more year as consultant to the institute and afterwards emigrated to Spain.

Dr G M Dreosti

Dr Dreosti was the first director of the Fishing Industry Research Institute (FIRI) in Cape Town and held this position from 1946 until his retirement in 1970.

Guido Mario Dreosti was born in Pretoria in 1905 and in 1926 obtained an MSc at the Transvaal University College (later the University of Pretoria). After a number of years in the teaching profession he resumed his studies at the University of Utrecht where he obtained a doctorate in industrial physics in 1930.

On his return to South Africa he was appointed to the Dehydration and Cold Storage Laboratory of the Department of Agriculture, and during the Second World War was concerned with food supplies to the armed forces. After 17 years at the laboratory he was appointed director of the newly founded FIRI in 1947. In 1950 he also became research professor at the University of Cape Town.

Dr Dreosti was a member of the scientific committee of the International Association of Fish Meal Manufacturers, of which he was for many years the chairman, and served on the panel of experts of the Food and Agricultural Organization of the United Nations. He was also chairman of the South West Africa Harbour Pollution Commission.

Dr P J du Toit

Dr du Toit was president of the CSIR from 1950 to 1952, a post-retirement position following a long and distinguished career as director of the Veterinary Research Institute, Onderstepoort.

Petrus Johann du Toit was born in 1888 and matriculated at the Hoër Jongenskool, Wellington. He took his first degree at Victoria College (later the University of Stellenbosch) and 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 and the University of Berlin awarded him the DrMedVet degree in 1916. He continued his research work in Germany during the First World War.

On his return to South Africa in 1918, Sir Arnold Theiler appointed him as a 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 became deputy president of the CSIR and in 1950 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, the Witwatersrand, Glasgow, Rhodes and the Orange Free State. Dr du Toit died in 1967.

Dr P R Enslin

Dr Enslin was director of the National Chemical Research Laboratory (NCRL) from 1973 until his retirement in 1983.

Pieter Retief Enslin was born in Lindley, OFS, in 1923, and obtained a BSc from the University of Stellenbosch in 1943, an MSc in plant physiology and organic chemistry from the University of Pretoria in 1946 and a DPhil from the University of Zürich in 1950.

He worked for a year in the Department of Agriculture and then joined the Organic Chemistry Division of the NCRL, becoming head of the division in 1962 and director of the laboratory in 1973, a post he held until his retirement.

Dr Enslin was awarded the Gold Medal of the SA Chemical Institute and the Havenga Prize for Chemistry by the Suid-Afrikaanse Akademie vir Wetenskap en Kuns.

Dr T C Erasmus

Dr Erasmus was appointed chief director of the National Institute for Coal Research in 1984.

Theunis Christiaan Erasmus was born in Krugersdorp in 1935 and graduated from the University of the Witwatersrand in 1958 with a BSc in chemical engineering. He obtained an MSc(Eng) and in 1972 a DSc(Eng) from the University of Pretoria.

Dr Erasmus joined the Fuel Research Institute in 1959, becoming deputy director in 1976, acting director in 1979 and director in 1983. When the institute was officially incorporated into the CSIR in 1984 it was renamed the National Institute for Coal Research with Dr Erasmus as chief director.

He was an external examiner in chemical engineering for the University of Pretoria and South African editor for the international journal *Fuel*.

Dr D W S Evans

Dr Evans was director of the South African Paint Research Institute from 1971 until 1973.

David Wilfred Shawyer Evans, a graduate of the University of London with a PhD in organic chemistry, was chief chemist at the Stanton Ironworks, a research worker, translator and abstractor at Nottingham University and head of gas chromatography at Boots Pure Drug

Company. He worked for Midland Silicones before coming to South Africa in 1971. He was at first assistant director and then director of the SAPRI. He returned to Britain in 1973.

Dr M W Feast

Dr Feast was appointed director of the South African Astronomical Observatory in 1976. (In 1983 the designation of this post was changed to chief director.)

Michael William Feast was born in England in 1926 and studied at the Imperial College, London, where he obtained a PhD in physics in 1949. Until 1951 he worked at the National Research Council of Canada in Ottawa on a postdoctoral fellowship, after which he was appointed a senior research officer at the Radcliffe Observatory, Pretoria. Dr Feast joined the staff of the SA Astronomical Observatory in 1974 and became director in 1976.

He was awarded the Gill Medal by the Astronomical Society of Southern Africa and became an honorary professor at the University of Cape Town. He was president of the International Astronomical Union's Commission of Stellar Spectra and of the Commission on Variable Stars, and was elected an Honorary Foreign Fellow of the Royal Astronomical Society in Britain and a Fellow of the Royal Society of South Africa.

Dr W S Finsen

Dr Finsen was director of the Republic Observatory in Johannesburg when it came under the jurisdiction of the CSIR in 1964.

William Stephan Finsen was born in Johannesburg in 1905 and after matriculating joined what was then the Union Observatory. He obtained his first degree from the University of South Africa and an MSc from the University of the Witwatersrand. The University of Cape Town conferred on him a DSc for his published works.

In 1957 Dr Finsen was appointed director of the Union Observatory which in 1961 changed its name to the Republic Observatory. He retired from this post in 1965.

Dr Finsen was well known internationally for his work on double stars. In 1975 the International Astronomical Union dedicated their Colloquium No. 33 to him; the subject of the meeting was 'Observational parameters and dynamic evolution of multiple stars'. He died in 1979.

Dr C F Garbers

Dr Garbers was appointed president of the CSIR in 1980.

Christoph Friedrich Garbers was born in Piet Retief, Transvaal, in 1929 and studied at the University of Pretoria where he obtained an MSc in 1951. He studied further at the University of Zürich where he worked under Professor P Karrer, a Nobel Prize winner in chemistry, and obtained a DPhil in 1954.

On his return to South Africa he worked in the CSIR's National Chemical Research Laboratory until 1958. During this time he was seconded to the University of the Witwatersrand as a lecturer and he also lectured part-time at the University of Pretoria. In 1958 he was appointed senior lecturer in organic chemistry at the University of Stellenbosch. He became professor in 1966 and also director of the CSIR's Polyene Chemistry Research Unit at the university in 1969.

In 1964 he received grants from the CSIR and the Ernest Oppenheimer Memorial Trust to do research under Nobel Prize winner Professor D H R Barton at the Imperial College of Science and Technology in London. During 1970 he studied further at the Technical University of Berlin.

In 1979 Dr Garbers became a vice-president of the CSIR, in 1980 deputy president and later the same year, after the death of Dr Brink, he was appointed president.

Dr Garbers was president of the SA Chemical Institute and the Suid-Afrikaanse Akademie vir Wetenskap en Kuns. In addition to serving on many official boards, he was a member of the board of the Hans Merensky Trust and the advisory board of the Claude Harris Leon and Percy Fox Foundations. From 1967 to 1977 he was scientific co-operator of Manufacture de

Produits Chimiques du Dauphin (France). He was awarded the Havenga Prize for Chemistry by the Suid-Afrikaanse Akademie vir Wetenskap en Kuns in 1977 and the Gold Medal of the SA Chemical Institute in 1980.

Dr D J Gouws

Dr Gouws was director of the National Institute for Personnel Research (NIPR) from 1962 to 1965.

David Johannes Gouws was born in Pretoria in 1926. He obtained a BSc from the University of Pretoria in 1946, a BA from the University of South Africa and an MSc in psychology from the University of Potchefstroom in 1952, and a DPhil from the University of Pretoria in 1957.

He taught high school mathematics for two years before joining the NIPR as a researcher in 1949. In 1954 he became a lecturer at the University of South Africa and after a year was appointed senior lecturer in psychology at the University of Pretoria. From 1958 to 1961 he worked as a Nuffield Fellow and then as a Special Post-Doctoral Fellow at the University of London. During this period he was also a visiting lecturer at the University of Pittsburgh, USA. He returned to the University of Pretoria as senior lecturer before becoming director of the NIPR. Dr Gouws resigned from this post to become executive director of a personnel consultancy in the Sanlam Group and in 1967 joined Sanlam's top management team. In 1972 he founded his own personnel consultancy.

Dr Gouws was a president of the Psychological Association of South Africa and a Fellow of the British Psychological Society. He was an honorary professor in industrial psychology at the Rand Afrikaans University and a professor extraordinary in business leadership at the School of Business Leadership of the University of South Africa.

Dr W L Grant

Dr Grant was director of the CSIR's National Mechanical Engineering Research Institute (NMERI) from 1957 until 1959.

Walter Lawrence Grant was born in Potchefstroom in 1922 and studied at the University of the Witwatersrand where he obtained a BSc(Eng) in 1948. He obtained an MSc in applied mathematics at the University of Pretoria in 1951 and was awarded a DSc(Eng) by the University of the Witwatersrand in 1957.

He joined the Mechanical Engineering Research Unit (later NMERI) in 1952 as head of the Thermodynamics Division and in 1957 became director. He was appointed chief engineer of the Atomic Energy Board (AEB) in 1959, deputy director general and director of reactor engineering in 1964 and in 1967 became director general of the AEB. In 1970 he was appointed deputy president of the AEB. In 1971 he became general manager of UCOR and in 1979 was appointed managing director.

Dr Grant was a member of various national and international professional societies and received several awards, among others the Gold Medal from the Institute of Mechanical Engineers, the Havenga Prize for Engineering from the Suid-Afrikaanse Akademie vir Wetenskap en Kuns, and the Claude Harris Leon Foundation's annual award in 1981. He was awarded honorary doctorates by the University of Pretoria and the Rand Afrikaans University and in 1983 he became honorary professor of mechanical engineering at the University of Pretoria.

Dr E C Halliday

Dr Halliday was head of the Air Pollution Research Group from its establishment in 1960 until his retirement in 1970.

Eric Clifford Halliday was born in Cape Town in 1904 and graduated from the University of Cape Town with an MSc in physics in 1926. In 1931 he obtained a PhD from the same university.

He lectured in the Physics Department of the University of the Witwatersrand from 1927 until 1945 during which time he spent his study leave at Cambridge and London Universities. In 1946 he was appointed head of the General Physics Division of the National Physical Laboratory and in 1960 became head of the Air Pollution Research Group.

Dr Halliday and his group were instrumental in drafting the Air Pollution Prevention Act of 1965. He was chairman of the National Air Pollution Advisory Committee and also the first chief air pollution control officer.

He belonged to the Air Pollution Control Association of the USA and was twice appointed member of the seven-man expert committee on environmental sanitation of the World Health Organization of the United Nations. He was awarded the Gold Salus Medal by the Department of Health, the SA Medal by the South African Association for the Advancement of Science, an honorary doctorate by the University of the Witwatersrand and the Decoration for Meritorious Service by the State President.

Professor G M Hamilton

Professor Hamilton was director of the South African Paint Research Institute (SAPRI) from 1952 until his retirement in 1971.

George Monty Hamilton (born 1906) obtained an MSc degree in London and in 1926 started his career as research chemist with the Research Association of British Paint, Colour and Varnish Manufacturers. In 1932 he became chief research chemist for the Callenders Cable and Construction Company and in 1947 joined British Insulated Callenders Cables. He worked briefly for the British Paint Research Institute at Teddington before coming to South Africa in 1952 to take up the post of director of SAPRI. In this capacity he was also professor at the University of Natal.

Professor Hamilton was a Companion of the Institute of Electrical Engineering (UK). He died in 1976.

Dr S H Haughton

Dr Haughton was a member of the CSIR Council from 1945 to 1947 and also for many years adviser to the CSIR on international geological matters.

Sidney Henry Haughton was born in London in 1888 and obtained a BA in geology from the University of Cambridge in 1909. In 1924 he was awarded a DSc by the University of Cape Town.

He taught for two years in England before coming to South Africa in 1911 as a palaeontologist-geologist at the South African Museum in Cape Town. Here he resumed his scientific studies, concentrating on the palaeontology of the Karoo. In 1915 he became assistant director of the museum. He left in 1920 to become senior geologist with the Union Geological Survey, and in 1934 was promoted to director of the Geological Survey, a position he held until his retirement in 1948.

This marked the beginning of a further 30 years in the service of science. For example, he was honorary scientific director of the Bernard Price Institute for Palaeontology at the University of the Witwatersrand from 1951 to 1973 and in 1969 became honorary professor of palaeontology.

Dr Haughton was a Fellow of the Royal Society of London, an honorary Fellow of the Royal Society of South Africa, a Fellow of the Geological Societies of London, America and Belgium, and an honorary member of the Geological Society of South Africa. He received honorary doctorates from the universities of Cape Town, the Witwatersrand and Natal. He died in 1982.

Mr J Hers

Mr Hers was acting director of the Republic Observatory from 1965 until it was amalgamated with the South African Astronomical Observatory in 1971.

Jan Hers was born in Holland in 1915 and matriculated at Potchefstroom, Transvaal. He obtained an MSc(Eng) from the University of the Witwatersrand.

He started his career in the technical section of the SA Broadcasting Corporation where he became interested in the measurement of high-frequency waves. In 1946 he joined the Union Observatory (later the Republic Observatory) where he developed the radio station ZUO for the transmission of accurate time signals and also became responsible for the administration of the observatory. In 1965 he was appointed acting director and was closely associated with

the planning of the new observing station for the SA Astronomical Observatory. After the Republic Observatory ceased to exist in 1971, Mr Hers joined the National Physical Research Laboratory where the transmission of time signals had been relocated. He retired from this post in 1976.

Dr F J Hewitt

Dr Hewitt was appointed a vice-president of the CSIR in 1964 and deputy president in 1972, a position he held until retiring in 1980.

Francis John Hewitt was born in Grahamstown in 1919 and obtained an MSc degree from Rhodes University in 1939. In 1957 he received a PhD from the University of the Witwatersrand.

During the Second World War he served in the radar development team under Sir Basil Schonland and later in the SA Corps of Signals. In 1943 he became company commander attached to coastal defence in Cape Town and in 1944 became assistant to the military adviser to the SA High Commissioner in London.

In 1946 he joined the CSIR as head of the Telecommunications Research Laboratory, and when it became the National Institute for Telecommunications Research in 1955 he was appointed director.

Dr Hewitt represented South Africa in various international scientific bodies such as the Scientific Committee for Antarctic Research. He was a president and an honorary Fellow of the SA Institute of Electrical Engineers, president of the Associated Scientific and Technical Societies of SA, the SA Council for Automation and Computation and an honorary member of the SA Institute of Physics. He received honorary doctorates from Rhodes University and the University of the Witwatersrand.

Dr G Heymann

Dr Heymann was appointed a vice-president of the CSIR in 1980, a post which was changed to that of deputy president in 1983.

Gerhardt Heymann was born in Rouxville in the Orange Free State in 1931 and obtained an MSc from the University of the Orange Free State in 1955. He continued his studies in England where he received a PhD from the University of London in 1960.

He started his career in 1951 as a researcher in the CSIR's National Physical Laboratory, became scientific officer at the Fishing Industries Research Institute in Cape Town and then at the physics laboratory of Sasol where he was also deputy head. In 1960 he was appointed head of the Nuclear Sciences Group of the CSIR's National Physical Research Laboratory. During 1962/1963 he worked at the Massachusetts Institute of Technology as a research fellow and in 1970 as a research fellow of the Rutherford High Energy Laboratory in Britain. In 1977 he became director of the National Accelerator Centre of the CSIR.

Dr Heymann was president of the South African Institute of Physics in 1983, chairman of the Environmental Impact Assessment Committee for Marion Island and an honorary professor of the University of the Witwatersrand.

Dr T Hodgson

Dr Hodgson was director of the CSIR's Technical Services Department (TSD) from 1972 until 1984. (The designation changed to chief director in 1983.)

Thomas Hodgson was born in Mateking in 1928 and studied at the University of the Witwatersrand where he obtained a BSc in mechanical engineering in 1949. He later received a PhD from the University of Natal.

He started his career at Crown Mines Ltd, obtained a Government Certificate of Competence (Mines and Works) and became section engineer. In 1957 he was appointed resident engineer for Pretoria Portland Cement Co. He joined the National Mechanical Engineering Research Institute (NMERI) in 1958 and became head of its Heat Mechanics Division in 1961. In 1973 he was appointed director of the TSD where one of his achievements was the institution of the CSIR's Production Engineering Advisory Service (PEAS). When PEAS was transferred to the

NMERI in 1984, Dr Hodgson became director of industrial development in that institute, a post he held until his death the following year.

He was president of the SA Institution of Production Engineering and a life vice-president of the SA Institute for Refrigeration and Air Conditioning from which he received a Gold Medal. He died in 1985.

Dr T J Hugo

Dr Hugo became director of the National Institute for Aeronautics and Systems Technology in 1977. (In 1983 the designation of this position was changed to chief director.)

Thomas Johannes Hugo was born in Vrede, OFS, in 1926. He studied at the University of Stellenbosch where he obtained an MSc in physics in 1947 and a DSc in 1953.

He joined the National Physical Laboratory as a researcher in 1947 and in 1950 was appointed as research assistant to Dr Meiring Naudé. During 1954/55 he worked at the National Research Council of Canada in Ottawa under the Nobel Prize winner Dr G Herzberg. On his return to South Africa in 1956 he was appointed as head of the Optics and Spectroscopy Division of the National Physical Research Laboratory. He represented South Africa at the 1960 and 1964 congresses of the International Commission on Lighting (CIE) and served on one of the expert committees of the commission.

In 1965 he was appointed director of the National Institute for Defence Research and in this capacity he was involved in a number of major technology transfers from the CSIR to industry.

In 1987 the Order of the Star of South Africa (Non-Military) Class II: Grand Officer (Silver) was awarded to Dr Hugo 'for outstanding meritorious service contributing significantly to the security and general national interest of the Republic of South Africa'.

Dr M S Hunt

Dr Hunt was appointed director of the National Mechanical Engineering Research Institute (NMERl) in 1981. (The designation of this post was changed to chief director in 1983.)

Michael Stanley Hunt was born in Britain in 1927 and graduated from Sheffield University with an MSc in mechanical engineering in 1949. He obtained a DSc(Eng) from the University of Pretoria in 1978.

After graduation he joined Armstrong Whitworth Aircraft Ltd as a design technician and in 1955 worked briefly for Massey-Ferguson before becoming chief stressman in the Rocket Division of Armstrong Siddeley Motors. By 1962 he was chief designer for this firm.

In 1965 he came to South Africa as project engineer and then chief research officer (engineering) with African Explosives and Chemical Industries (AECI). In 1967 he was transferred to the Somerset West dynamite factory as section engineer and soon became assistant factory manager (chief engineer). Following an old interest he joined the Atlas Aircraft Corporation in 1968 as manager of the Technical Division. In 1970 he came to the CSIR as head of the Design and Structures Division of the NMERl's Aeronautics Research Unit. When the unit was transferred to another institute in 1978, he became head of NMERl's Process Mechanics Division. In 1979 he was appointed assistant director and in 1981 director of the institute.

Several patents were taken out in his name by Bristol Siddeley, AECI and the CSIR.

Professor D H Jacobson

Professor Jacobson was a vice-president of the CSIR from 1980 until 1985. (In 1983 the designation of this post was changed to deputy president.)

David Harris Jacobson was born in Johannesburg in 1943 and obtained a BSc(Eng) from the University of the Witwatersrand in 1963. He continued his studies at the Imperial College, London, and obtained a PhD in electrical engineering as well as the diploma of the Imperial College in 1967. In 1968, on a postdoctoral fellowship, he did research at Harvard University and became assistant and later associate professor of engineering. During his stay at Harvard he was also visiting research associate at the University of California, Berkeley, for six months.

In 1972 he was appointed professor in the mathematical field within the Department of Applied Mathematics at the University of the Witwatersrand. He resigned in 1975 to become director of the CSIR's National Research Institute for Mathematical Sciences but retained the position of honorary professor at the University. He became a vice-president of the CSIR in 1980. In 1985 he left the CSIR to take up a post in industry.

In 1965 he was awarded the SA Cable Makers' Association Award and in 1974 he was chosen by the SA Junior Chamber of Commerce as one of the 'four outstanding young South Africans'. He was elected a Fellow of the Institute of Electrical and Electronics Engineers and also a Fellow of the South African Institute of Electrical Engineers.

Professor C Jacobsz

Professor Jacobsz was director of the National Research Institute for Mathematical Sciences (NRIMS) from 1973 until his retirement in 1974.

Charlotte Jacobsz was born in Kestell, OFS, in 1909, and obtained a BSc from Grey University College (later the University of the Orange Free State) in 1929, an MSc in mathematics from the University of South Africa and a BSc(Eng) from the University of the Witwatersrand.

He worked at Iscor as an engineer, becoming joint head of works engineering before being appointed professor of mathematics at the University of Pretoria in 1946. He returned to Iscor as standards and specifications engineer in 1957 and in 1960 took up an appointment as professor with special responsibility for engineering mathematics at the University of Stellenbosch. In 1964 he joined the CSIR as head of the Numerical Analysis Division of the NRIMS. He died in 1981.

Mr J E B Jennings

Mr Jennings was director of the CSIR's National Building Research Institute (NBRI) from 1947 to 1955.

Jeremiah Edmund Bowden Jennings was born in Krugersdorp in 1912 and graduated from the University of the Witwatersrand in 1933 with a BSc in civil engineering. He joined the Irrigation Department and shortly afterwards returned to Wits as junior lecturer. The award of a Union postgraduate bursary in 1935 enabled him to study at the Massachusetts Institute of Technology for an MSc followed by a period of study at the University of California.

Returning to South Africa in 1937, he joined the South African Railways and Harbours and lectured part-time at Wits. In 1946 he became head of the Engineering Division of the NBRI and director of the institute in 1947. He was appointed professor of civil engineering at the University of the Witwatersrand in 1954 and retired in 1975.

Professor Jennings was elected an honorary member of the Institute of South African Architects and of the SA Chapter of Quantity Surveyors. He was also a founder member of the International Society of Soil Mechanics and Foundation Engineering of which he was a vice-president from 1957 to 1961. He was president of the SA Institute of Civil Engineers (SAICE) and in 1961 played a leading role in the formation of the Professional Engineers' Joint Council, the forerunner of the SA Council of Professional Engineers. In 1963 he was awarded the Gold Medal and in 1978 was elected honorary Fellow of the institute.

The Geotechnical Division of the SAICE instituted the J E B Jennings Award in his honour. He was also a president of the Associated Scientific and Technical Societies of South Africa. The University of the Witwatersrand conferred on him an honorary doctorate and the University of Natal a DSc for a thesis based on his published work. He died in 1979.

Professor D M Joubert

Professor Joubert was a vice-president of the CSIR from 1977 until 1978.

Daniel Malan Joubert was born in Pretoria in 1928 and studied at the University of Pretoria where he obtained an MSc(Agric) in 1952. Further study took him to Cambridge, where he was awarded a PhD in 1955. He also obtained a DSc degree from the University of Stellenbosch in 1976.

He returned from Cambridge to the University of Pretoria as a senior lecturer and later became professor in the Faculty of Agriculture. In 1962 he joined the Department of

Agricultural Technical Services as assistant director of research, retaining his ties with the university as associate professor. When in 1970 he became director of auxiliary services he was also director general of the Southern Africa Regional Commission for the Conservation and Utilization of Soil (SARCCUS). In 1974 he was appointed director of the Department's Transvaal region. In 1977 he became a vice-president of the CSIR and in 1979 returned to Pretoria University as vice-rector and became rector in 1982.

Awards received by Professor Joubert included the Havenga Prize from the Suid-Afrikaanse Akademie vir Wetenskap en Kuns, the Gold Medal from the SA Society for Animal Production, the Senior Captain Scott Medal from the SA Biological Society and the South Africa Medal from the SA Association for the Advancement of Science. He was president of the Joint Council of Scientific Societies in 1976 and of the Association for the Advancement of Science from 1978 to 1980, and served as vice-president of the Royal Society of South Africa from 1982 to 1985.

Dr J F Kemp

Dr Kemp was appointed a vice-president of the CSIR in 1971 and became deputy president in 1980.

Jacobus Frederick Kemp was born in Harrismith in 1928. He studied at the University of Stellenbosch, graduated as a mechanical engineer in 1950, obtained an MSc(Eng) in 1956 and a PhD(Eng) in 1958. After graduation he worked for the SA Railways and Harbours and in 1952 joined the CSIR's Mechanical Engineering Research Unit (later the National Mechanical Engineering Research Institute). In 1962 he became senior lecturer at the University of Pretoria. During this time he studied in England, Scotland and Germany. In 1963 he was appointed professor of mechanical engineering at the University of Stellenbosch. He returned to the CSIR as a vice-president in 1971.

Dr D G Kingwill

Dr Kingwill was director of the CSIR's Information and Research Services (IRS) from its foundation in 1962 until his retirement in 1982.

Denys Graham Kingwill was born in Graaff-Reinet in 1917, and graduated from Rhodes University in 1939 with an MSc in physics. He served in the Second World War in the meteorological section of the SA Air Force. In 1945 he became professional assistant to Dr Basil Schonland who was entrusted with the task of establishing the CSIR. As such, Dr Kingwill was also head of the CSIR's Liaison Division and was responsible for developing a number of activities aimed at creating an environment conducive to scientific research in South Africa. In 1962 many of these activities were brought together under the IRS and Dr Kingwill was appointed director.

He was a president of the Associated Scientific and Technical Societies of SA, the SA Association for the Advancement of Science and of the SA Antarctic Association. He was elected Fellow of the SA Institute for Library and Information Science in 1974, and was granted honorary membership in 1985. He was awarded an honorary doctorate by Rhodes University in 1984.

Mr A Krüger

Mr Krüger was manager of the Estates Services Department from 1968 until his death in 1981.

Abraham Krüger was born in 1929. After matriculating at the Paarl Boys' High School in 1946, He joined the Department of Lands and in 1949 was appointed to the administrative staff of the National Building Research Institute. In 1957 he became responsible for the administration of the Estates Services Department and in 1968 was made manager.

Dr G J Kühn

Dr Kühn was appointed head of the Magnetic Observatory at Hermanus in 1977.

Gideon Jacobus Kühn was born in Uppington in 1942 and graduated from the University of Stellenbosch with a BSc in 1961. He continued his studies at the Potchefstroom University

where he obtained a DSc in physics in 1969. He also lectured at the University College of the North. From 1968 until 1975 he was stationed at the Magnetic Observatory at Hermanus where he was responsible for the Potchefstroom University's Antarctic research programmes on cosmic rays. In 1975 he joined the Uranium Enrichment Corporation, becoming head of the section for nuclear safety until his appointment as head of the observatory.

Dr Kühn was a member of the 1964 Antarctic expedition and in 1974 received the Antarctic Gold Medal of the SA Antarctic Association.

Dr S H Kühn

Dr Kühn was appointed director of the National Institute for Road Research (NIRR) in 1970. In 1976 the institute became the National Institute for Transport and Road Research (NITRR). (The designation of this post was changed to chief director in 1983.)

Stephanus Hendrik Kühn was born in Williston, Cape Province, in 1921 and graduated from the University of Stellenbosch in 1942 with a BSc. He obtained a BSc(Eng) from the University of Cape Town in 1944, an MSc(Eng) from the University of the Witwatersrand in 1948 and a DSc(Eng) from the University of Pretoria.

Dr Kühn started his career in 1944 with the Roads Department of the Cape Provincial Administration as assistant engineer, rising to become regional engineer. In 1948 he joined the Municipality of Pretoria and in 1951 the CSIR's newly founded Bituminous Binder Research Unit which developed into the NIRR. In 1954 he was sent for a year to work at the Road Research Laboratory in Britain and studied part-time at the Regent Street Polytechnic. At the NIRR he became head of the Group for Special Problems and in 1967 head of the Materials and Design Branch. The following year he was appointed assistant director of the institute and director in 1970.

Mr P Lasserre

Mr Lasserre was appointed head of the Technical Services Department (TSD) in 1984.

Patrice Lasserre was born in Brussels, Belgium, in 1943. He trained as Ingénieur ECAM (Electricity and Mechanics) and obtained a diploma in business administration at the University of Brussels.

After serving in the Belgian army he underwent industrial training in France and Britain and then worked for two years in the project and design group of the firm Monsanto in Luxembourg. In 1970 he joined Chevron Oil where he worked in various capacities on assignments in Belgium and Britain. He came to South Africa in 1984 to take up an appointment with the CSIR.

Dr A W Lategan

Dr Lategan was the first director of the CSIR's National Nutrition Research Institute (NNRI), a position he held from 1954 to 1956.

Andries Willem Lategan was born in Burgersdorp in 1915. He studied at the University of Pretoria where he obtained a BSc in 1937 and an MSc in 1940. In 1946 he obtained a PhD from the University of Cape Town.

He joined National Chemical Products Ltd as a chemist and later became chief chemist, and from 1949 until 1952 he was principal technical officer in the Food Chemistry Division of the South African Bureau of Standards. He left the bureau to become technical adviser to the Federal Group of Companies until his appointment as first director of the CSIR's National Nutrition Research Institute. In 1956 he was appointed director of the SABS – a post he held until his death in 1965.

Dr Lategan served on many official bodies. He was chairman of the SA Advisory Committee on Automotive Parts and a member of the Scientific Advisory Council and of the Council of the Pretoria Technical College.

Professor L J le Roux

Professor le Roux was vice-president of the CSIR from 1962 until 1965.

Lodewikus Jacobus le Roux was born in Lichtenburg, Transvaal, in 1914 and obtained an MSc at Potchefstroom University and a BCom from the University of South Africa. His studies for a doctorate at the University of London were interrupted by the Second World War. He returned to South Africa to lecture, initially at Potchefstroom University and then at the University of Pretoria where he received a DSc in 1953. He was appointed professor of physical chemistry at the University of Pretoria, a post he held until 1959 when he joined the Atomic Energy Board as chief chemist. In 1962 he was appointed as vice-president of the CSIR responsible for defence research. In the same year he became honorary professor at the University of Pretoria.

He was the deputy commanding officer of the Scientific Corps of the SA Armed Forces and a life member of the Royal Artillery Association of Britain. He died in 1986.

Mr W G B Mandersloot

Mr Mandersloot was appointed head of the Chemical Engineering Research Group of the CSIR in 1969.

William George Bernard Mandersloot was born in the Netherlands in 1928 where he graduated in chemical engineering in 1953. After working at MEKOG and Caltex and doing research at the Central Technical Institute of the TNO in the Netherlands, he moved to South Africa in 1957 to join the Chemical Engineering Group of the National Chemical Research Laboratory. In 1973 the group became an independent entity under Mr Mandersloot.

Mr Mandersloot was elected a Fellow and council member of the SA Institute of Chemical Engineering. He represented the CSIR on the boards of the International Fine Particles Research Institute as well as of the Separation Processes Service and the Heat Transfer and Fluid Flow Service of Britain.

Professor E J Marais

Professor Marais was vice-president of the CSIR from 1962 to 1964.

Ernst Jacobus Marais was born in Vredefort, OFS, in 1921 and studied at the universities of the Orange Free State and Stellenbosch, obtaining an MSc degree. He lectured at Rhodes University for a year before returning to the University of Stellenbosch where he received a doctorate in 1945.

In the following year he joined the National Physical Laboratory (NPL) and, as head of optics and mass spectroscopy, was sent for two years' postdoctoral study in Britain and the USA. In 1955 he became director of the NPL and in 1962 a vice-president of the CSIR. In 1964 he was appointed first rector of the University of Port Elizabeth, a post he held until 1981. He then became chairman of the Science Committee of the President's Council, a position he held until his death in 1984.

Dr D H Martin

Dr Martin was appointed director of the National Research Institute for Mathematical Sciences (NRIMS) in 1980. (In 1983 the designation of this post was changed to chief director.)

Duncan Henry Martin was born in Durban in 1941 and completed his BSc(Hons) degree at the University of Natal in 1962. In 1965 he obtained a PhD in mathematics from the University of South Africa and in the same year was appointed assistant professor at the California State College at Hayward, USA. From 1966 to 1967 he was visiting professor of mathematics at the University of British Columbia in Canada, and the following year he was appointed senior lecturer in mathematics and applied mathematics at the University of Natal, Durban. He joined the NRIMS in 1977, becoming deputy head of the Mathematics Division in 1978 and director of the institute in 1980.

Dr Martin was a president of the Mathematics Society of SA.

Dr M Matic

Dr Matic was director of the Sugar Milling Research Institute (SMRI) from 1966 until 1979 when he retired.

Milorad Matic was born in Yugoslavia in 1920 and graduated in engineering at the University of Geneva. Later he received a PhD in chemistry from the University of South Africa. He was director of the SMRI as well as professor at the University of Natal.

Dr Matic came to South Africa in 1951 to join the CSIR's National Chemical Research Laboratory. In 1958 he became chief chemist for Epic Oil Mills in Johannesburg and the following year senior scientist at the Chamber of Mines Research Laboratory where he remained until his appointment as director of the SMRI. After retiring in 1980, he was visiting professor at the Louisiana State University and lectured part-time at the University of Durban-Westville. In 1984 he became director of the Association of Pulp, Paper and Board Manufacturers of SA.

Dr Matic was an honorary member of the associations of sugar technologists of South Africa, Italy and the USA. He was also vice-president of the International Commission for Uniform Methods of Sugar Analysis.

Mr A J Miller-Smit

Mr Miller-Smit was secretary/treasurer of the CSIR from 1955 until his retirement in 1963.

He was born in Worcester in the Cape Province in 1903 and in 1923 graduated with a BA from the University of Cape Town. In 1932 he obtained an MComm from the University of South Africa. He worked for the Union Department of Education in Pretoria before becoming a lecturer at the Cape Town Technical College in 1927. During the Second World War he was again employed by the Department of Education and in 1946 he joined the newly founded SA Bureau of Standards where he was secretary/treasurer before his appointment as secretary/treasurer of the CSIR. He died in 1985.

Dr J Morris

Dr Morris was appointed chief director of the National Building Research Institute (NBRI) in 1984.

John Morris was born in Bloemfontein in 1931 and graduated from the University of Pretoria with an MSc in chemistry in 1955. In 1959 he obtained a DSc from the Catholic University of Louvain, Belgium.

He joined the staff of Iscor's Research and Process Development Division as a junior researcher in 1955, eventually becoming senior research officer. He joined the NBRI as a senior research officer in the Materials Division in 1966, and in 1968 became head of the new Organic Materials Division. Dr Morris was appointed by the CSIR as counsellor, science and technology, in London in 1978, a post he held until his appointment as chief director of the NBRI in 1984.

Dr R J Nachenius

Dr Nachenius was director of the Fishing Industry Research Institute (FIRI) in Cape Town from 1970 until he retired in 1981.

Reinhard Johannes Nachenius was born in Germany in 1921. He studied at the University of Cape Town where he obtained a BSc(Eng) and a PhD in mechanical engineering.

Dr Nachenius started his career in 1947 in the Dehydration and Cold Storage Laboratory of the Department of Agriculture, and worked as factory manager and factory engineer with various fishing companies. In 1954 he joined the FIRI as research officer, becoming assistant director in 1966 and director in 1970.

Dr S M Naudé

Dr Naudé was president of the CSIR from 1952 to 1971.

Stefan Meiring 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 the Nobel Prize winners Einstein, von Laue, Planck and Nernst. After obtaining his doctorate in 1928 he did 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 did research under Professors Mulliken and Compton and established 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 Dr Naudé 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 (S.A.) 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 Suid-Afrikaanse 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 G K Nelson

Dr Nelson was appointed director of the National Institute for Personnel Research (NIPR) in 1977. (In 1983 the designation of this post was changed to chief director.)

Gordon Kenneth Nelson was born in Johannesburg in 1928 and studied at the University of the Witwatersrand where he obtained a BA(Hons) in 1951 and subsequently an MA and a PhD in psychology. He joined the NIPR in 1953 as assistant technician and became head of the Neuropsychology Division in 1962 and assistant director in 1973. Three years later he was appointed director of the institute.

Dr Nelson was a president of the SA Association for the Advancement of Science, the SA Electro-encephalographic Society and the SA Psychological Association of which he was made an honorary life member. He became honorary professor of psychology at the University of the Witwatersrand and at the University of Port Elizabeth.

Dr L Novellie

Dr Novellie was appointed director of the National Food Research Institute (NFRI) in 1979. (The designation of this post was changed to chief director in 1983.)

Lawrence Novellie was born in Pietermaritzburg in 1921 and received an MSc in organic chemistry from the University of Natal in 1946 and a PhD in biochemistry in 1959. He began his career at the CSIR in 1949 in the Microbiological Chemistry Division of the National Chemical Research Laboratory (NCRL) and later became head of the Sorghum Beer Unit which was eventually transferred to the NFRI.

He played a leading role during the formative years of the northern branch of the SA Association for Food Science and Technology and was chairman of the branch and vice-president of the association.

Professor S F Oosthuizen

Professor Oosthuizen, professor of radiology at the University of Pretoria, was the CSIR's adviser on medical research and chairman and honorary secretary of the CSIR's Committee for Research in the Medical Sciences. He was appointed to the CSIR Council in 1946 but resigned in order to carry out these responsibilities. He served on the council again from 1962 until 1970.

Sarel Francois Oosthuizen was born in Ventersburg in 1910 and graduated with an MB ChB from the University of Cape Town in 1934. After several years in general practice, he continued his studies in London, obtaining a DMR and then the MRCP, Royal College of Surgeons. He returned to South Africa in 1939 to join the Radiology Department of the Groote Schuur Hospital, Cape Town. In 1944 he was appointed professor of radiology at the University of Pretoria where he received a DSc degree. After retiring from the university he joined the SA Defence Force, finally to retire with the rank of brigadier.

Professor Oosthuizen was president of the SA Medical and Dental Council, chairman of the Transvaal Public Hospitals Advisory Council, and adviser on radiology to the Transvaal Provincial Administration and to the Minister of Mines. He was a Fellow of the Royal College of Physicians of Edinburgh, the Faculty of Radiologists in London and the American College of Radiologists. He died in 1981.

Dr A Pizzi

Dr Pizzi became chief director of the National Timber Research Institute (NTRI) in 1984.

Antonio Pizzi was born in Rome in 1946. He obtained a doctorate in chemistry from the University of Rome in 1970, a PhD (applied organic chemistry) from the University of the Orange Free State in 1977 and a DSc (wood science) from the University of Stellenbosch in 1985.

Dr Pizzi came to South Africa in 1969 and worked as a research chemist in various industries before joining the NTRI in 1976. He became head of the Adhesives Section in 1977, head of the Composite Products Division in 1978, and later head of the Chemistry and Adhesives Division. In 1983 he was appointed assistant director of the NTRI and in the same year he was seconded to Burman Adhesives and Sealants Ltd as technical director. He became chief director of the institute in 1984.

Dr Pizzi received a CSIR Merit Award in 1985 for his work on wood adhesives and waterborne wood preservatives.

Dr Bernard Price

Dr Price, chairman of the Victoria Falls and Transvaal Power Company, was a member of the first CSIR Council on which he served until his death in 1948.

Bernard Price was born in Kent, England, in 1877. He trained as an engineer and physicist at the Central Technical College in London after which, for eight years, he was chief electrical assistant to the firm of Merz and McLellan. During this time he contributed to important inventions in the field of electrical power machinery.

In 1909 he came to South Africa as chief engineer to the Victoria Falls and Transvaal Power Company (later incorporated into Escom). In 1926 he became general manager and in 1936 resident director of the firm.

From 1914 until 1918 he was chairman of the government Advisory Committee on Science and Technology. He was president of the SA Institute of Engineers and the Associated Scientific and Technical Societies of SA. He was also a member of the council of the University of the Witwatersrand and of the Social and Economic Planning Council.

Through his generous endowments the Bernard Price Institute for Geophysical Research was established in 1937 and the Bernard Price Institute for Palaeontological Research in 1949.

In 1920 he was awarded the Order of the British Empire, and the University of the Witwatersrand awarded him an honorary doctorate for his contributions to science, engineering and education in South Africa.

Dr F W Quass

Dr Quass was director of the National Nutrition Research Institute (NNRI) from 1957 to 1965.

Franz Wilhelm Quass was born in Middelburg, Transvaal, in 1914 and studied at the University of Pretoria where he obtained a BSc in 1933, an MSc in 1935 and a DSc in 1940.

He started his research career in 1933 with the Fuel Research Institute. He worked for the Department of Commerce and Industry as senior professional officer from 1946 until 1950, during which time he spent two years as industrial liaison officer attached to the CSIR scientific liaison office in Washington DC. He returned to the Fuel Research Institute and in 1951 he became industrial adviser to the Natural Resources Development Council. He was appointed director of the NNRI in 1956, a post he held until his appointment as general manager of the Southern Oil Exploration Corporation (Soekor) in 1965. After retiring in 1975, he remained for some years on the council of Soekor and also served on the Scientific Advisory Council.

Dr Quass was a president of the SA Nutrition Research Society.

Dr W S Rapson

Dr Rapson was vice-president of the CSIR from 1958 to 1962.

William Sage Rapson was born in New Zealand in 1912. He obtained an MSc at the Auckland University College and in 1935 a PhD in chemistry at Oxford University. In the following year he came to South Africa as senior lecturer at the University of Cape Town and was professor-designate in organic chemistry when he was appointed the first director of the CSIR's National Chemical Research Laboratory in 1947. In 1958 he became vice-president of the CSIR and in 1962 he resigned to take up an appointment as research adviser to the Chamber of Mines. On his retirement he became manager of the Chamber's productivity campaign and then consultant to the International Gold Corporation.

A Fellow of the Royal Institute of Chemistry and of the Royal Society of SA, Dr Rapson was awarded honorary doctorates from the University of Cape Town, the University of the Witwatersrand and the Rand Afrikaans University. He was president of the Associated Scientific and Technical Societies in 1967 and was awarded the Gold Medal of the SA Chemical Institute in 1973.

Dr A B Ravnö

Dr Ravnö was appointed director of the Sugar Milling Research Institute (SMRI) in Durban in 1979.

Albert Bernard Ravnö was born in Johannesburg in 1939, graduated with an MSc from the University of Natal and later obtained a PhD and DIC from Imperial College, London. He started his career as a chemist with AECI at Modderfontein in 1964 and two years later joined SAPREF in Durban as a process engineer. In 1972 he became project development engineer for Ngoye Paper Mills and in 1974 joined Hulett's Sugar at Mt Edgecombe as chief development officer and later consulting technologist before becoming director of the SMRI five years later.

Dr Ravnö was director of Sugar Processing Research Inc., president of the SA Sugar Technology Association, chairman of the SA National Committee for the International Commission for Uniform Methods of Sugar Analysis and a vice-president of the International Commission.

Dr D Reitmann

Dr Reitmann became director of the National Accelerator Centre in 1980. (In 1983 the designation of this post was changed to chief director.)

Daniel Reitmann was born at Nieuwoudtville, Cape Province, in 1934 and studied at the University of the Orange Free State where he received a DSc degree in physics in 1958. After completing further research in nuclear physics at the CSIR cyclotron in Pretoria he went to the University of Oxford where he received a DPhil degree in 1961.

He joined the Atomic Energy Board (AEB) and was sent for further training to the Argonne National Laboratory in the USA. On his return in 1969 he was appointed deputy director of the Physics Division of the AEB.

Dr Reitmann was president of the SA Institute of Physics and was its representative on the Joint Council of Scientific Societies. He was also South Africa's liaison officer for the nuclear data committee of the International Atomic Energy Agency.

Dr P J Rigden

Dr Rigden was a vice-president of the CSIR from 1970 until his retirement in 1979.

Philip James Rigden was born in Chelmsford, England, in 1914. He received an MSc in physics in 1938 and a PhD in 1950 from Reading University. In 1938 he joined the road research laboratory of the Department of Scientific and Industrial Research at Harmondsworth, England, and became head of the bituminous materials division. In 1951 he came to South Africa to take up an appointment as director of the Bituminous Binder Research Unit set up by the CSIR. In 1955 the unit was incorporated in the National Institute for Road Research, of which Dr Rigden became the first director.

He was appointed a vice-president of the CSIR in 1970 and from 1972 until 1980 was the first chairman of the National Road Safety Council. During his career he was an invited speaker and chairman at various international conferences and published papers on road research, road traffic and road accidents. He was elected a Fellow of the Institute of Physics in Britain, and a member of the British Institute of Highway Engineers.

After retiring, Dr Rigden joined the SA Inventions Development Corporation as a project manager.

Dr A J A Roux

Dr Roux was a vice-president of the CSIR from 1957 to 1959.

Abraham Johannes Andries Roux was born in Bethlehem, OFS, in 1914. In 1936 he obtained an MSc(Eng), in 1939 a BSc(Hons) in mathematics and in 1943 a DSc from the University of the Witwatersrand. While studying, he worked as an engineer at the Langlaagte Estate Mine and from 1939 lectured in the Department of Mechanical Engineering at Wits. In 1944 he was appointed senior lecturer at the University of Stellenbosch. He joined the CSIR in 1946, initially as principal research officer in the National Building Research Institute. In 1952 he became director of the National Physical Laboratory and in 1955 was appointed the first director of the National Mechanical Engineering Research Institute.

In 1957 Dr Roux was appointed a vice-president of the CSIR with special responsibility for drafting an atomic energy research programme. In 1959 he left the CSIR to become research director and later president of the Atomic Energy Board (AEB). When the Uranium Enrichment Corporation (Ucor) was founded in 1970 he became chairman of the board. He retired from the AEB in 1979 and from Ucor in 1982.

Dr Roux was chairman of the Suid-Afrikaanse Akademie vir Wetenskap en Kuns in 1963, president of the SA Institute of Mechanical Engineers in 1960 and 1961, and a member of the Institution of Mechanical Engineers, London.

He received the Havenga Prize for Engineering (1959) and the MT Steyn Prize (1977) from the Suid-Afrikaanse Akademie vir Wetenskap en Kuns. He was awarded honorary doctorates from the universities of Stellenbosch, Pretoria, the Orange Free State and the Witwatersrand. He received the State President's Decoration for Meritorious Service in 1980, and in 1983 the Grand Cordon of the Order of the Brilliant Star from the Republic of China. He died in 1985.

Mr A M Schady

Mr Schady was manager of the South African Inventions Development Corporation (Saidcor) from its foundation in 1962 until his retirement in 1982.

Alfred Martin Schady was born in Port Elizabeth in 1922 and studied at Rhodes University in Grahamstown where he obtained a BSc degree in 1942. In 1947 he received a BSc in chemical engineering from the University of the Witwatersrand. During the Second World War he

served in the special signals service. In 1948 he joined AECl and the following year started his career at the CSIR as a research officer in the Liaison Division. From 1953 to 1956 he was in charge of the CSIR's scientific liaison office in London. On his return he was given responsibility for the CSIR's inventions development activity in the Liaison Division, which led to the establishment of Saidcor as a separate statutory body.

Dr B F J Schonland

Dr Schonland was the first president of the CSIR and served the organization from 1945 to 1950.

Basil Ferdinand Jamieson Schonland was born in Grahamstown in 1896. He obtained a BA(Hons) degree at Rhodes University and continued his studies at Cambridge. During the First World War he served with the signals section of the Royal Engineers. He was discharged with the rank of Major and Chief Instructor, Wireless Communications, having been decorated 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 Cape Town University. He completed his research for a PhD from Cambridge and turned his attention increasingly to 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 the lightning discharge mechanism.

On the outbreak of the Second World War 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'.

At the end of 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 director 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, the 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.

Mr V A Shaw

Mr Shaw was director (later chief director) of the CSIR's Centre for Computing Services from 1980 until 1984 when he became chief director of the National Institute for Informatics.

Victor Allan Shaw was born in Johannesburg in 1927 and graduated from the University of the Witwatersrand with a BSc(Eng) in 1950. He also obtained an MSc(Eng) from the University of the Witwatersrand and a BSc(Hons) in operations research from Unisa.

After graduating Mr Shaw worked for nine years for various consulting engineering and construction firms. He started his CSIR career in 1961 with the National Building Research Institute where he managed the Construction Industry Computer Information Centre from 1972 until 1980 when he became director of the Centre for Computing Services. When the centre and the CSIR's Centre for Scientific and Technical Information were amalgamated in 1984 to form the National Institute for Informatics, he became its first chief director.

Mr Shaw was elected a Fellow of the SA Institute of Civil Engineers.

Professor S G Shuttleworth

Professor Shuttleworth was the first director of the Leather Industries Research Institute (LIRI). He held this post from 1941 until his retirement in 1974.

Stanley Gordon Shuttleworth was born in Johannesburg in 1911. He graduated from Rhodes University College with a BSc in 1930 and was the first student at that college to receive a PhD. He was later awarded a PhD and a DSc from the University of Leeds.

He studied at Leeds University as a Procter Research Fellow and then as a Hunt Rankin Research Fellow at Lehigh University, USA, becoming technical director to Bona Allen in Georgia. In 1941 he returned to South Africa to become research professor at Rhodes University College and founded the LIRI. During the Second World War he was Assistant Controller (Technical) of Leather.

Professor Shuttleworth received an honorary doctorate from the University of the Orange Free State, and the Gold Medal of the SA Chemical Institute. He was elected a Fellow of the British National Boot and Shoe Institute, was the founder and first president of the SA section of the International Society of Leather Trades Chemists and was a Mayor of Grahamstown.

Prof E S W Simpson

Professor Simpson was the first director of the CSIR's National Research Institute for Oceanology (NRIO), a position he held from 1974 until 1976.

Eric Stanley Wayne Simpson was born in Dundee, Natal, in 1924. He served as a naval officer during the Second World War and graduated from the University of Cape Town with an MSc in geology in 1949. He obtained a PhD at Cambridge in 1952 and returned to UCT as a lecturer in geology. He became Head of the Geology Department in 1957, dean of the Faculty of Science in 1963 and head of the Department of Oceanography in 1964. When he relinquished the post of director of the NRIO in 1976 he returned to UCT as professor and director of the Institute of Oceanography where he remained until his death in 1983.

Professor Simpson was president of the Scientific Committee on Oceanic Research, of the International Council of Scientific Unions and recipient of the Grimaldi Award for Oceanography. He was a Fellow of the Royal Society of SA, and president of the Geological Society of SA.

Dr J Smeath Thomas

Dr Smeath Thomas, Master of Rhodes University College, Grahamstown, served on the first CSIR Council from 1945 to 1947.

John Smeath Thomas was born in 1886 and studied at the University of Liverpool where he obtained a doctorate in chemistry and became senior lecturer in analytical chemistry in 1919. He came to South Africa in 1923 as professor of inorganic chemistry at the University of Cape Town. In 1938 he was elected Master of Rhodes University College, a post he held for 10 years.

Dr Smeath Thomas was awarded an honorary doctorate by Rhodes University.

He died in 1971.

Dr G J Stander

Dr Stander was director of the National Institute for Water Research (NIWR) from 1958 to 1971.

Gert Johannes Stander was born in Philippolis, OFS, in 1911 and studied at the University of Cape Town where he obtained an MSc in 1935 and a DiplAnalChem in 1936. In 1951 he obtained a PhD from the University of the Witwatersrand.

He became municipal chemist in Pretoria in 1937, city biochemist in East London in 1939 and joined the Water Treatment Division of the National Chemical Research Laboratory of the CSIR in 1948. In 1958 he was appointed first director of the NIWR which had evolved from the Water Treatment Division. He left the NIWR in 1971 to become chief executive and later chairman of the Water Research Commission from which he retired in 1979.

Dr Stander was elected Fellow of the British Institute of Sewage Purification in 1963, became an honorary member of the Water Pollution Control Federation of America and was president of the International Association for Water Pollution Research. He was a recipient of the National Award of the Associated Scientific and Technical Societies of SA, and was awarded the MT Steyn Medal for Science and Technology from the Suid-Afrikaanse Akademie vir Wetenskap en Kuns and the Gold Medal of the SA Chemical Institute. He was an honorary professor of chemical engineering at the University of Pretoria and received honorary doctorates from the universities of Potchefstroom, Cape Town and the Orange Free State.

Dr A Strasheim

Dr Strasheim was director of the National Physical Research Laboratory from 1962 to 1982.

Albertus Strasheim was born in Bloemfontein in 1917 and received an MSc in physics from the University of Stellenbosch in 1939. He joined the Western Province Fruit Research Institute as a researcher in 1940, at the same time working at the University of Stellenbosch towards his DSc degree which he received in 1945. He joined the National Physical Laboratory as head of the Spectroscopy Division in 1947 and was appointed director of the laboratory in 1962. After his retirement in 1982 he again took up full-time spectroscopic research in the Chemistry Department of the University of Pretoria.

Dr Strasheim was chairman of the SA Institute of Physics and an active member of the International Union for Pure and Applied Physics, serving for many years on two of its commissions. He was a Fellow of the Institute of Physics and the Physical Society, England, and a member of Applied Spectroscopy, USA.

Dr T P Stratten

Dr Stratten was a member of the CSIR Council from its inception until 1954.

Thomas Price Stratten was born in 1904 and obtained a BSc from the University of Cape Town in 1924. At Oxford, on a Rhodes Scholarship, he obtained an MA in engineering in 1927. After two years with the American Electric Company in New York he returned to South Africa as assistant electrical engineer at De Beers Mines in Kimberley. In 1931 he became chief electrical engineer to the newly founded Iscor. He joined Union Corporation in 1938 and later became chief consulting mechanical and electrical engineer. As assistant director general of war supplies (technical) during the Second World War he set up organizations for the manufacture of military requirements and opened offices in other Commonwealth countries.

After the war he became manager, deputy managing director and then managing director and chairman of Union Corporation from which he retired in 1970. He was appointed honorary president of the corporation in 1972.

Dr Stratten was president and later honorary member of the SA Institute of Electrical Engineers, president of the Associated Scientific and Technical Societies of SA, director of the National Finance Corporation and the SA Reserve Bank. The University of the Witwatersrand awarded him an honorary doctorate. He died in 1980.

Dr N Stutterheim

Dr Stutterheim was a vice-president of the CSIR from 1959 to 1967 and deputy president from 1967 to 1969.

Born in Bethal, Transvaal, in 1915, Niko Stutterheim graduated as a chemical engineer from the University of the Witwatersrand in 1937. He received a DSc(Eng) from the university in 1961.

After working in industry for some years, he was attached to a housing research unit at Wits for three years before joining the National Building Research Institute in 1946 as head of the Materials Division. He became director of the institute in 1955.

In 1969 Dr Stutterheim left the CSIR to become managing director and member of the board of directors of Noristan Ltd. He served on the boards of various companies and after his retirement was chairman of Standard Telephones and Cables (SA) Ltd, Soekor and Powerlines Ltd.

He was president of the Associated Scientific and Technical Societies of SA, the SA Chemical Institute and the Engineers' Association of SA, and chairman of the Urban Foundation and of the Wits University council. The Suid-Afrikaanse Akademie vir Wetenskap en Kuns awarded him a Medal of Honour for Scientific Achievement as well as the Havenga Prize for Engineering. The SA Chemical Institute awarded him the Hendrik van Eck Medal for his outstanding contributions towards commerce and the community in general, and he received an honorary doctorate from the University of Cape Town.

Dr J J Theron

Dr Theron was director of the National Nutrition Research Institute (NNRI) from 1965 to 1969.

Johan Jurgen Theron was born in Bloemfontein in 1925 and studied at the University of Pretoria where he obtained a BSc in 1945, an MB ChB in 1951, an MSc in 1957 and a DSc in physiology in 1962.

After working as a junior pathologist at the SA Institute for Medical Research in Johannesburg, he joined the NNRI as head of the Division for Histopathology and Cytology in 1955. At the NNRI he was briefly responsible for two other divisions, the Field Studies Division and the Nutrition Research Division. He also lectured part-time at the University of Pretoria. In 1965 he was appointed director of the NNRI.

When the nutritional diseases component of the NNRI was transferred to the Medical Research Council on its establishment in 1969, Dr Theron became vice-president of the new council. In 1971 he was appointed associate professor in the Department of Physiological Chemistry at Pretoria University and in 1977 was appointed professor in the Department of Physiology.

Dr D F Toerien

Dr Toerien was appointed chief director of the National Institute for Water Research (NIWR) in 1984.

Danie Francois Toerien was born in Middelburg, Transvaal, in 1940. He studied microbiology at the University of Pretoria where he obtained a BSc(Agric) degree in 1961 followed by an MSc and a DSc(Agric) in 1969. He continued his studies as a postdoctoral fellow at the University of California, Berkeley, and returned to South Africa in 1971.

Dr Toerien lectured at the University of Pretoria from 1963 until he joined the NIWR in 1966, where he became head of the Limnology Division in 1971. In 1976 he was appointed professor at the University of the Orange Free State and director of its Institute for Environmental Sciences.

Dr Toerien was president of the Limnology Society of Southern Africa.

Dr D W F Turpie

Dr Turpie was appointed director of the SA Wool and Textile Research Institute (SAWTRI) in 1979. (In 1983 the designation of this post was changed to chief director.)

Derek William Fraser Turpie was born in Durban in 1929 and graduated BSc at the University of Natal in 1951. He obtained an MSc degree and a PhD, both in textile science, from the University of Port Elizabeth.

After graduating, he entered the family business of wool merchants and topmakers of which he became managing director in 1963. While with the firm he gained valuable experience in the technical as well as the commercial aspects of the textile industry and also received formal training in London, Bradford and Switzerland.

Dr Turpie joined SAWTRI in 1967 as head of the Department of Carding and Combing. At the same time he resumed his academic studies and lectured part-time at the University of Port Elizabeth. He became assistant director of SAWTRI in 1979 and later in the same year was appointed director.

An active member of the SA branch of the Textile Institute of Manchester, he was awarded the Emblem of the Institute for his services in 1978. He became professor extraordinary of textile science at the UPE.

Sir Richard van der Riet Woolley

Sir Richard was the first director of the South African Astronomical Observatory (SAAO), a position he held from 1973 to 1976.

Richard van der Riet Woolley was born in 1906 and obtained an MSc from the University of Cape Town and a PhD from the University of Cambridge.

He worked at the Mount Wilson Observatory in California, USA, and then as Isaac Newton Student at Cambridge before becoming chief assistant of the Royal Observatory in Greenwich in 1933. He returned to Cambridge in 1937 as John Couch Adams Astronomer and in 1945 was appointed Commonwealth Astronomer in Australia and, as such, director of the Mount Stromlo Observatory. He became Astronomer Royal in 1956 and following his retirement in 1971 became director of the newly founded SAAO in Cape Town. He retired from this position in 1976.

Sir Richard was a vice-president of the International Astronomical Union, a president of the Australian and New Zealand Association for the Advancement of Science and a Fellow of the Royal Society, London. He died in 1987.

Mr J van der Staaij

Mr van der Staaij was director of the CSIR's Technical Services Department from 1963 until his retirement in 1972.

Jan van der Staaij was born in 1909 in Delft, Holland, where he obtained Advanced Certificates in Technical Drawing, Mathematics and Electrotechnics. He worked as an instrument-maker and designer in the Department of Physics of the University of Delft from 1928 to 1938 and then joined the Bataafsche Petroleum Maatschappij (Shell) where he was in charge of the instrument department.

Mr van der Staaij came to South Africa in 1948 to develop the workshop of the National Physical Laboratory which initially served the entire CSIR. From 1949 onwards he was involved in the training of apprentices as instrument-makers and repairers, and one of his main achievements was the establishment of a national centre for the training of technicians in a collaborative venture with the education authorities. When various workshop facilities at CSIR institutes were centralized under the Technical Services Department in 1959, Mr van der Staaij was appointed head of the department. In 1963 he was promoted to director.

Dr J P van der Walt

Dr van der Walt was head of the CSIR's Microbiology Research Group from 1961.

Johannes Petrus van der Walt was born in Pretoria in 1925. In 1947 he obtained an MSc in chemistry from the University of Pretoria and became CSIR research assistant to the director of the university's Institute for Pathology. In June 1952 he received a DSc in chemistry and microbiology at the Technical University of Delft, Netherlands.

He returned to South Africa to join the Biochemical Section of the CSIR's National Chemical Research Laboratory where he undertook microbiological investigations in the production of sorghum beer. In 1959 and 1960 he led the CSIR's Wine Research Unit at Stellenbosch. In 1961 he became head of the CSIR's Microbiology Research Group within the National Nutrition Research Institute (later the National Food Research Institute).

Dr van der Walt was internationally recognized as an authority on the microbiology of yeasts. In 1969 he was invited by the International Association of Microbiological Societies to serve on the International Commission for Yeasts, and in 1980 by the International Union of Biological Sciences to serve on the Special Committee for Fungi and Lichens of the International Association for Plant Taxonomy. He was research adviser to the National Research Institute for Nutritional Diseases of the Medical Research Council. From 1980 until 1983 he was an honorary professor of the University of Pretoria and in 1984 became an honorary professor of the University of the Orange Free State.

Dr E N van Deventer

Dr van Deventer was appointed a vice-president of the CSIR in 1980. (The designation was changed to deputy president in 1983.)

Edgar Neville van Deventer was born in Brakpan in 1929. He worked at Iscor and then at the CSIR while studying part-time at the University of Pretoria where he obtained a BSc in 1952. He joined the SA Weather Bureau and studied part-time at the University of South Africa for an MSc which he obtained in 1955. In that year he returned to the CSIR where he worked mainly for the National Building Research Institute, with a short interval in industry, until 1972 when he was transferred to the Computer Centre of the National Research Institute for Mathematical Sciences. In that year he was awarded a PhD from the University of South Africa. In 1973 he became head of the Computer Centre and in 1976 assistant director. In 1979 the Computer Centre became a separate CSIR institute with Dr van Deventer as its first director.

He was chairman of the National Advisory Committee on Library and Information Science.

Dr H J van Eck

Dr van Eck, who was chairman and managing director of the Industrial Development Corporation (IDC) for 20 years, was a member of the CSIR Council from 1945 to 1970.

Hendrik Johannes van Eck was born in the Kimberley district in 1902. After obtaining an MSc degree in chemistry from the University of Stellenbosch in 1921 he continued his studies in Germany, first in Leipzig and then in Berlin, receiving a DrIng degree from the Technische Hochschule, Berlin-Charlottenburg, in 1927.

He worked in industry in Britain for a year before returning to South Africa as chemical engineer and fuel technologist at the Electricity Supply Commission in 1928. From 1930 to 1932 he was technical adviser to the Fuel Research Institute. He joined Iscor in 1933, becoming joint works manager in 1935. In the following year he became consulting chemical engineer to Anglo-Transvaal Consolidated Investment Company and to the SA Torbanite Mining and Refining Company, and also managing director of Dunswart Iron and Steelworks. In 1940 he joined the IDC as managing director, and became managing director and chairman in 1944. In 1964 he relinquished the post of managing director but continued as chairman.

Councils and commissions on which Dr van Eck served as chairman included the Social and Economic Planning Council, the Munitions Production Board, the Industrial and Agricultural Requirements Commission and the Commission of Inquiry into the Oil Pipeline Project. He was president of the South African Chemical Institute in 1939 and 1940 and of the Associated Scientific and Technical Societies in 1943. He received honorary doctorates from the universities of Natal, Rhodes, the Witwatersrand, Cape Town and Stellenbosch, and from the Drexel Institute of Technology, Philadelphia, USA. He died in 1970.

Dr R van Houten

Dr van Houten was the first director of the CSIR's Centre for Scientific and Technical Information (CSTI) and held this post from 1980 until his retirement in 1984. (In 1983 the designation of this post was changed to chief director.)

Robert van Houten was born in Indonesia in 1924 and obtained a degree in electrical engineering from the University of Technology, Delft, in 1954. He obtained an MBA from the University of Pretoria in 1962 and a DBA from the University of Potchefstroom in 1966.

He worked for Philips, Eindhoven, before coming to South Africa in 1955 to join the Division of Civil Aviation of the Department of Transport. In 1962 he started his career at the CSIR as an industrial economist in the Information and Research Services (IRS). In 1967 he became head of the newly established Technical Information Service for Industry in the IRS and in 1970 head of the Scientific and Technical Information Group. In 1975 he was appointed assistant director of IRS and headed the Centre for Scientific and Technical Information. In 1980 the CSTI became an independent CSIR institute with Dr van Houten as director.

Dr van Houten was South Africa's representative on the International Council of Scientific Unions Abstracting Board as well as a member of its executive committee.

Mr J F van Straaten

Mr van Straaten was director of the National Building Research Institute (NBRI) from 1980 until 1984. (The designation of this post was changed to chief director in 1983.)

Jacob Francois van Straaten was born in Hofmeyr, Cape Province, in 1924. He graduated from the University of Stellenbosch with a BSc in 1943 and obtained a BSc(Eng) in 1945 and an MSc(Eng) in 1951.

Mr van Straaten joined the NBRI in 1946 and he became head of the Functional Efficiency Division in 1958, assistant director in 1975 and director in 1980.

He received the Silver Medal and a special merit award from the National Development Fund of the Building Industries Federation of SA for his book *Thermal Performance in Buildings*. He was a recipient of the T L Webb Award of the Bester group of companies for his contributions to building research.

Mr A M van Wijk

Mr van Wijk was head of the Magnetic Observatory (MO) in Hermanus from 1946 until his retirement in 1977.

Andrew Murray van Wijk was born in Kuils River, Western Cape, in 1914 and graduated with an MSc in physics from Rhodes University in 1935.

He worked for the Chamber of Mines until 1938 when he joined the Magnetic Observatory under the Department of Lands. From 1943 to 1946 he was seconded to the Department of Defence, serving under the Director General of Supplies. After the Second World War he returned to the observatory as head, a post he retained after the CSIR assumed responsibility in 1969.

Mr J D N van Wyk

Mr van Wyk was appointed director of the National Electrical Engineering Research Institute (NEERI) when it was established in 1971. (The designation of this post was changed to chief director in 1983.)

Jan Daniël Naudé van Wyk was born in Lady Grey, Cape Province, in 1927 and obtained a BSc in electrical engineering from the University of the Witwatersrand in 1949.*

He joined the CSIR at the end of 1949. In 1953, as a recipient of a UNESCO bursary, he did postgraduate studies at the Chalmers Institute of Technology in Gothenburg, Sweden. In 1957 he became head of the Electrotechnical Engineering Division of the National Physical Research Laboratory and in 1961 was transferred to the newly founded National Research Institute for Mathematical Sciences as assistant director and head of the Electrical Engineering Research Department. In 1970 this department became a separate CSIR institute, the NEERI, with Mr van Wyk as director.

As president of the Engineering Association of SA, the SA Council for Automation and Computation and the SA Institute of Electrical Engineers, he played a leading role in the International Federation of Automatic Control as a member of the advisory committee, a chairman of the Technical Committee on Computers, and vice-chairman of the Technical Board.

* He was awarded an honorary doctorate by the Rand Afrikaans University in 1986.

Dr J S V van Zijl

Dr van Zijl was appointed chief director of the National Physical Research Laboratory (NPRL) in 1983.

Jan Stephanus Viljoen van Zijl was born in Boksburg in 1935. He graduated from the University of Stellenbosch in 1955 and joined the staff of the Geological Survey of the Department of Mines. In 1958 he obtained an MSc degree from the University of Pretoria and in 1961 a PhD (geophysics) from the University of the Witwatersrand.

Dr van Zijl joined the Geophysics Division of the NPRL in 1962 and became head of the division in 1969. He was promoted to assistant director of the laboratory in 1980 and the following year left the CSIR to become group geophysicist at Gencor. He returned to the CSIR in 1983 to become chief director of the NPRL.

Dr van Zijl was awarded the Jubilee Medal of the Geological Society of SA in 1978 for a publication entitled *The Relationship between the Deep Electrical Resistivity Structure and Tectonic Provinces in South Africa*.

Mr J D van Zyl

Mr van Zyl was appointed secretary to the CSIR and director of the CSIR's Administrative Services Department in 1975. (The designation of this post was changed to chief director in 1983.)

Jacobus Daniel van Zyl was born in Clanwilliam in 1932 and obtained a BCom and an MBA from the University of Pretoria. He started his career in 1951 in the office of the Auditor General in Pretoria. In 1954 he became an accountant at the SA Bureau of Standards and joined the CSIR in 1956 as secretary of the National Institute for Road Research.

Dr D P Veldsman

Dr Veldsman was director of the SA Wool and Textile Research Institute (SAWTRI) from 1964 to 1979.

Daniël Petrus Veldsman was born in Britstown, Cape Province, in 1924 and studied at the University of Potchefstroom where he obtained an MSc degree in mathematics in 1946 and an MSc in chemistry in 1947. In 1950 he was awarded a DSc in organic chemistry by the University of Pretoria.

He started his career in 1948 with the Veterinary Research Institute, Onderstepoort, and in 1951 joined the newly founded SAWTRI. In 1952 the institute sent him to the University of Leeds, England, for postgraduate training in textiles. He left the SAWTRI to become research manager of a Uitenhage textile factory in 1959 and returned to the SAWTRI in 1964 as director. In 1979 he resigned to become director of the Port Elizabeth Technikon.

Dr Veldsman was appointed professor extraordinary of textile technology at the University of Port Elizabeth in 1969, served on the SA Wool Board and was a member of the Research and Development Committee of the International Wool Secretariat.

In 1977 the Textile Institute of Manchester honoured him with its Annual Award.

Mr R W Vice

Mr Vice was appointed director of the National Institute for Telecommunications Research (NITR) in 1964. (In 1983 the designation of this post was changed to chief director.)

Raymond Worling Vice was born in Sterkstroom, Cape Province, in 1925 and graduated from the University of the Witwatersrand in 1948 with a BSc(Eng). He joined the NITR in 1949. In 1955/56 he did research at the Jodrell Bank radio astronomy station in Britain.

Mr J H Visagie

Mr Visagie was secretary/treasurer of the CSIR from 1964 until his death in 1975.

Johannes Hendrik Visagie was born in Standerton in 1922 and studied at the University of Pretoria where he obtained BA and BCom degrees. He joined the administration of the SA Bureau of Standards in 1949 and was transferred to the CSIR when the two bodies were amalgamated, in 1957. When they separated again in 1962, Mr Visagie elected to remain with the CSIR as assistant secretary/treasurer.

Mr D J M Vorster

Mr Vorster was director of the National Institute for Personnel Research (NIPR) from 1965 until 1977 when he retired.

David Johannes Mentz Vorster was born at Steynsburg, Cape Province, in 1917. He obtained a BA from the University of the Orange Free State and a BA(Hons) from the University of Pretoria. He also obtained an Advanced Technical Certificate and a National Technical Teachers' Certificate.

Mr Vorster started his career with the Victoria Falls and Transvaal Power Company after which he joined the Heidelberg Municipality. For six years he was a technical teacher with the then Union Department of Education. He joined the NIPR in 1947 as research officer and in 1949 became a senior research officer in charge of the Pretoria division of the institute. From 1957 Mr Vorster worked for the Anglo American Corporation of SA as personnel officer, personnel manager and regional personnel manager until his appointment as director of the NIPR.

Mr Vorster, a Fellow of the SA Institute of Personnel Management, was a president and an executive member of the institute for many years.

Dr T L Webb

Dr Webb was director of the National Building Research Institute (NBRI) from 1959 to 1980.

Thomas Lodewyk Webb was born in Cradock in 1919. He graduated from the Rhodes University College in 1939 with a BSc. In 1958 he received a DSc from the University of Pretoria.

After graduating he joined the National Road Board in 1940 and did research on soil mechanics and cement stabilization. He served in the SA Corps of Signals during the Second World War and started his career at the NBRI as research officer in 1947, becoming head of the Materials Division in 1955 and director of the institute in 1959. After his retirement in 1980 he became professor extraordinary at the School of Business Leadership of the University of South Africa.

He received a number of honorary awards in recognition of the contributions of the NBRI under his direction. These included honorary membership of the Institute of South African Architects, the SA Institute of Building, the Institute of Housing Management and the SA Ceramic Society.

Dr Webb was a member of the International Council for Building Research and of the Permanent Committee of the International Society for Cements and Materials. In 1984 Rhodes University awarded him an honorary doctorate.

Dr J P H Wessels

Dr Wessels was appointed director of the Fishing Industry Research Institute (FIRI) in Cape Town in 1981.

Jacobus Pieter Hermanus Wessels was born in Harrismith, Orange Free State, in 1929. He obtained a BSc from the University of Pretoria, an MSc from the University of Natal and a DSc from Rutgers University in the USA.

Dr Wessels lectured at various agricultural colleges before joining the staff of the University of Natal where, in 1970, he became associate professor of animal and poultry science. He joined the FIRI in 1971 as assistant director, became deputy director in 1977 and director in 1981.

Professor R W Wilcocks

Professor Wilcocks, rector of the University of Stellenbosch, was a member of the first CSIR Council on which he served from 1945 until 1961.

Raymond William Wilcocks was born in Vryburg, Cape Province, in 1892. He graduated from the old Victoria College (later the University of Stellenbosch) in 1912 with a BA in philosophy and continued his studies in Germany where he obtained a PhD from the University of Berlin

in 1917. In that year he was appointed professor of logic and psychology at Victoria College. In 1933 he became chairman of the university senate and in 1935 first rector of the University of Stellenbosch, a post he held until his retirement in 1954. During his term of office he initiated various important developments at the university, including the establishment of the Faculties of Engineering and Medicine.

Professor Wilcocks was awarded an honorary doctorate by the University of Stellenbosch. He died in 1967.

Professor D E A Williams-Wynn

Professor Williams-Wynn was director of the SA Paint Research Institute (SAPRI) in 1973 and 1974.

David Ernest Arthur Williams-Wynn was born in Pretoria in 1930 and graduated at Rhodes University where he obtained an MSc and a PhD in chemistry. He started his career at Plascon Paint in Krugersdorp in 1950. In 1954 he was appointed a scientific officer at the British Leather Manufacturers' Research Association in Britain. He returned to South Africa in 1956 to take up an appointment as a chief research officer at the Leather Industries Research Institute in Grahamstown. In 1973 he was appointed director of SAPRI and in 1975 when the institute was closed down he became a professor in the Department of Chemistry at the University of Natal in Durban.

Professor Williams-Wynn was chairman of the Natal branch of the SA Chemical Institute and vice-president of the Oil Colour Chemists' Association.

Mr J E Worsdale

Mr Worsdale was a member of the first CSIR Council on which he served from 1945 until 1964.

John Everard Worsdale was born in Hull, England, in 1897. After serving in the First World War he obtained a BSc degree in chemistry from the Royal College of Science, London, and in 1921 joined the cement firm, G & T of Hull. He came to South Africa in 1929 as chief chemist to the Pretoria Portland Cement Company (PPCC). In 1940 he became manager of the Cape Portland Cement Company and in 1947 technical manager of PPCC. In 1950 he joined the Whites Cement Company in Britain, becoming managing director of Whites SA Portland Cement Company. In 1961, on his retirement, he was made adviser to Whites Portland Cement worldwide.

Apart from his service as a CSIR council member, Mr Worsdale was a member of the advisory committees of the CSIR's National Institutes for Building and Personnel Research.

He was chairman of the SA Cement Producers Executive and president of the Associated Scientific and Technical Societies of SA and of the SA Chemical Institute. He was also an Associate of the Royal College of Science and a Fellow of the Royal Institute of Chemistry. He died in 1975.

Appendix 4

CABINET MINISTERS THROUGH WHOM THE CSIR REPORTED TO PARLIAMENT

The council is "... a corporate body, outside the Government Service . . . It is, however, responsible to Parliament, through the Prime Minister, for its programme and its estimates."

(Objects and Policy of the South African Council for Scientific and Industrial Research – an initial Statement Council for Scientific and Industrial Research, Pretoria 1945, p. 5.)

"18. The State President may by proclamation in the Gazette assign the administration of this Act to any Minister . . ."

(The Scientific Research Council Act No. 32 of 1962, as amended.)

The Cabinet Ministers to whom this responsibility was assigned, were:

- 1945–47 : Gen J C Smuts, Prime Minister of the Union of SA
- 1948–50 : Dr D F Malan, Prime Minister of the Union of SA
- 1951–54 : Dr E H Louw, Minister of Economic Affairs
- 1955–58 : Dr A J R van Rhijn, Minister of Economic Affairs
- 1959–63 : Dr N Diederichs, Minister of Economic Affairs
- 1964–65 : Adv J F W Haak, Minister of Planning
- 1966–69 : Dr Carel de Wet, Minister of Planning
- 1970–71 : Mr J J Loots, Minister of Planning
- 1972–74 : Mr J J Loots, Minister of Planning and the Environment
- 1975–77 : Dr S W van der Merwe, Minister of Planning and the Environment
- 1978 : Mr J C Heunis, Minister of Economic Affairs, Environmental Planning and Energy
- 1979 : Dr S W van der Merwe, Minister of Industries, Commerce and Consumer Affairs
- 1980 : Mr F W de Klerk, Minister of Mining and of Environmental Planning and Energy
- 1981–85 : Dr D J de Villiers, Minister of Industries, Commerce and Tourism

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