



CSIR

ANNUAL REPORT

1985

40 Years in Research and Development

Reflection hologram of the Taung skull. The original transmission hologram was produced at the National Physical Research Laboratory (see story in the section 'Other activities'). The hologram is produced here by kind permission of **National Geographic Magazine** and was supplied by the American Banknote Company.



 CSIR

Council for Scientific and Industrial Research

ANNUAL REPORT

1985

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of individual institutes

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Council members



FRONT ROW (l. to r.)

Mr R A Plumbridge

Chairman, Gold Fields of South Africa Ltd

Prof. H P van der Schijff

Vice-Principal, University of Pretoria

Dr C F Garbers

Chairman – President, CSIR

Dr C van der Pol

Chairman, Tongaat-Hulett Sugar Ltd

Dr L B Knoll

Retired Deputy Chairman, FedMech Holdings Ltd

BACK ROW (l. to r.)

Prof. O W Prozesky

Department of Medical Virology, Institute of Pathology, University of Pretoria

Mr J A Stegmann

Managing Director and Deputy Chairman, South African Coal, Oil and Gas Corporation Ltd

Mr E Pavitt

Chairman, General Mining Union Corporation Ltd

Mr W P Venter

Chief Executive, Allied Technologies Ltd

Mr M T de Waal

Managing Director and Chief Executive, Industrial Development Corporation of South Africa Ltd

Inset left:

Prof. D S Henderson

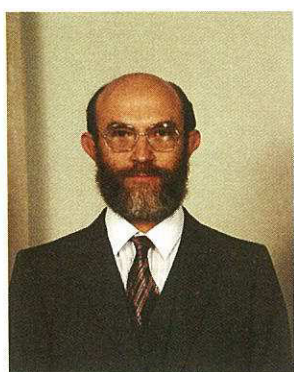
Principal and Vice-Chancellor, Rhodes University

Inset right:

Mr E van As

Group Managing Director and Chief Executive, Sappi Ltd

Executive



Prof. D H Jacobson who resigned as Deputy President during the year.

FRONT ROW (l. to r.)

| | |
|---------------------|------------------|
| Mr J P de Wit | Deputy President |
| Dr C F Garbers | President |
| Dr E N van Deventer | Deputy President |

BACK ROW (l. to r.)

| | |
|-----------------|------------------|
| Dr J F Kemp | Deputy President |
| Prof. R R Arndt | Deputy President |
| Dr G Heymann | Deputy President |

Foreword by the President

Forty years on

'This is the century of applied science, of the application of the results of laboratory research to every activity of mankind' - these words formed the first sentence of an outline of the objects and policy of the CSIR at its first Council meeting forty years ago on 8 October 1945. In the relatively short period of time since then, the CSIR has developed to become, as predicted by Field Marshall J C Smuts, 'one of the most important organizations in this country'. The task of the CSIR, as defined by its founder and first President, Sir Basil Schonland, is as valid today as it was forty years ago: the application of research to exploit fully the country's natural resources, raw materials and waste products, to seek new knowledge through research in addition to promoting scientific research generally and to foster the training of R & D manpower. Furthermore, its task is to assist industry, to collect and disseminate scientific and technical information and, finally, to liaise with other countries in matters relating to scientific and industrial research.

The past forty years have witnessed phenomenal progress in science and technology, with standards of living raised to unprecedented heights. At the same time, there has been constant fierce competition between various countries for scientific and technological supremacy. For those who have been able to compete successfully the rewards have been high. In South Africa, the CSIR has contributed extensively towards making the country a scientific and technological force to be reckoned with. In this the CSIR has had the active collaboration of many institutions in both the public and the private sectors.

From recent events in South Africa and reactions abroad, the message of 1985 is clear: in future South Africa will have to rely on its own resources to a much greater extent.

The vision which led to the establishment of the CSIR in 1945 contributed greatly towards South Africa now having at its disposal a highly developed scientific infrastructure with the ability to find solutions to many technical problems and to exploit the vast amount of knowledge generated internationally. However, with South Africa contributing less than 0,2 per cent of world financing towards R & D, it stands to reason that this country, like most others, cannot ever hope to be self-sufficient in science and technology. It should be emphasized that South Africa has always met its international scientific commitments, which is significant considering the global nature of many research programmes, our unique geographical situation and our first-hand experience of African conditions.

Over the past forty years the CSIR has contributed extensively to many fields, for example housing, infrastructure in general, water and food, with the aim of improving the quality of life in Southern Africa. We are indebted to many scientists all over the world who have collaborated with us in the spirit of the universality of science.

Involvement in industry

The CSIR's activities are spread throughout the country. There is wide-ranging collaboration with 32 state departments, commissions and councils, as well as with all universities, museums and technikons. A thousand bursaries are made available every year for post-graduate studies. In addition, over the past three years there has been scientific collaboration with 14 African countries. Many of the CSIR's 25 institutes, laboratories, groups and units serve one or more particular industrial sector, and approximately 2 500 R & D contracts are undertaken annually on behalf of industry. Specialized services include the processing and retrieval of scientific and technological information from all over the world, the Production Engineering Advisory Service, the National Calibration Service, the maintenance of primary standards and the CSIR's Conference Centre which serves as a focal point for the transfer and exchange of scientific and technological knowledge.

In the White Paper on Industrial Development Strategy published in May 1985, the CSIR, which has the necessary infrastructure for the transfer of technology to industry, was identified as the organization which, in collaboration with the Department of Trade and Industry, should take the lead in devising an appropriate mechanism for the transfer of

Foreword by the President

technology. After extensive deliberations in this regard, the CSIR will in future place still greater emphasis on its statutory responsibility of serving South Africa's industrial needs.

Major events of 1985

As far as research results are concerned, 1985 was another successful year for the CSIR. Many research projects, scientific and technological successes and lines of investigation for the future are discussed in this report. Some of the more important events which should be singled out for special mention are:

- The new 200 MeV Open Sector Cyclotron near Faure in the Western Cape was officially opened on 18 October by the State President, Mr P W Botha. The idea of its construction was conceived in 1966. Building commenced in 1977 and it was built to remarkable levels of precision and accuracy exclusively by South African scientists and engineers. The National Accelerator Centre, which is responsible for the cyclotron, aims to provide for basic and applied research with accelerated particles; radiotherapy with high-energy particles for the treatment of cancer; and the production of radioisotopes for medical and industrial applications. The decision by the Cabinet that the CSIR should construct this accelerator, has launched the CSIR into the 'big science' league.

- Another facility which was officially opened in 1985 was the fluidized-bed reactor of the National Institute for Coal Research. This facility will be used for research aimed at the efficient utilization of the country's coal reserves, especially the vast reserves of low-grade coal.

- On 30 July 1985 the National Institute for Personnel Research (NIPR) was formally transferred to the Human Sciences Research Council (HSRC). Throughout its existence the NIPR has always maintained scientific excellence in its outstanding contributions towards human endeavour, and towards increased productivity in the growing industrial sector. The CSIR looks forward to effective future collaboration with the NIPR now that it has been transferred to the HSRC.

- As was provided for in the original agreement of January 1972 between the Science and Engineering Research Council of the United Kingdom (SERC) and the CSIR, the SERC has decided to suspend its financial contribution towards the running of the South African Astronomical Observatory (SAAO) as from June 1986. Since this decision was taken, the CSIR has received letters from leading astronomers around the world confirming South Africa's important and long-standing contribution towards astronomy, and urging the CSIR to maintain the SAAO's dynamic research programme.

Conclusions

Nineteen eighty-five, the year of the CSIR's 40th anniversary, was indeed an occasion to pause and reflect on past achievements and a year in which to anticipate our direction in future. What emerged was that:

- The CSIR should continue to play its role as one of the leaders in science and technology in South Africa. We shall have access internationally at the highest technological level only where we have something to offer.

- The CSIR should be far more closely involved in South African industry and should ensure that the technology employed is the best available. This is especially applicable to small and medium-sized industries.

- The CSIR should endeavour to assist in technology development for the processing of our raw materials for national and international markets, thus adding to their value.

- The CSIR, in its R & D programme, should carefully take into account demographic tendencies and their attendant problems.

- The CSIR should foster closer collaboration in and co-ordination of R & D throughout South Africa.

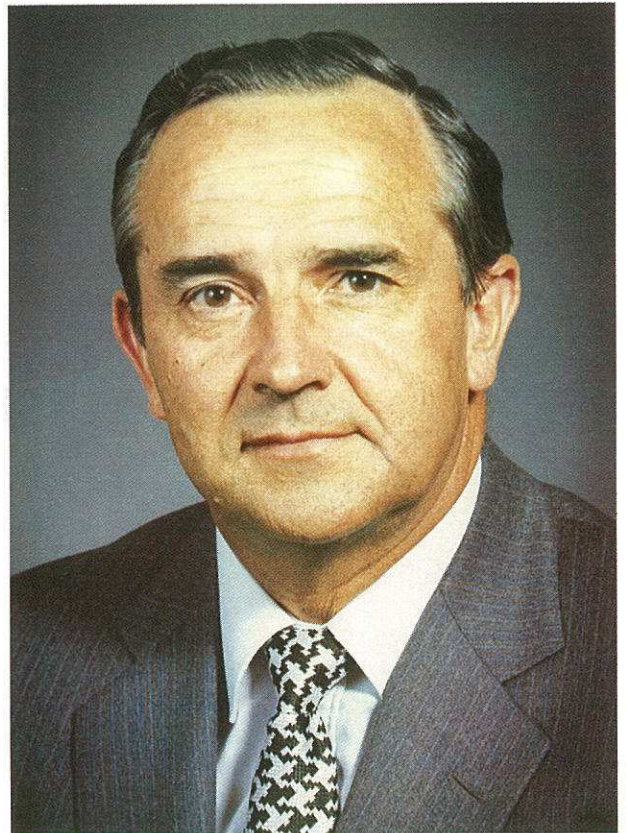
Foreword by the President

Although South Africa is undergoing a difficult period, I am convinced that adversity will stimulate us all to greater efforts. I am grateful to the many departments and institutions that have so strongly supported the CSIR during these times of acute financial and other pressures. In particular I wish to refer to the additional funding made available to maintain the momentum of the Main Research Support Programme at universities, museums and technikons by the Foundation for Research Development. I would also like to express my thanks to the CSIR Council members, the numerous external specialists who acted in an advisory capacity, and the CSIR staff members who, through their efforts and inventiveness, have helped to make the CSIR a centre of excellence with direct beneficial consequences for the country. With such support I can look forward confidently and with enthusiasm to the future.

C. F. Garbers

PRESIDENT

April 1986



The CSIR – 40 years of research

Science in South Africa before 1945

The CSIR is today a fine example of what careful planning and the establishment of the right working climate for research can achieve. From a small number of carefully selected and enthusiastic scientists in various disciplines, the CSIR has grown into an excellent research establishment and a major force in the industrial development of South Africa.

Before Union in South Africa, there was virtually no scientific research being done in the country, but after Union in 1910 there was increasing involvement by the Government in specific fields of scientific research, notably in agriculture, mining and metallurgy. The two World Wars forced the country to move towards becoming more industrially orientated, with the growing need for research and development.

By 1945 organized industrial research in South Africa had begun to take shape, but although some of the larger firms maintained laboratories, very few actually had research departments. A national research organization was proposed by Field Marshall J C Smuts. Dr Basil Schonland (later Sir

Dr Basil Schonland – President 1945-1950



Basil Schonland) was given the task of setting up a statutory organization for scientific research.

The first Council meeting

At the first formal meeting of the Council on ⁸ October 1945, a basic policy statement was discussed. *The Objects and Policy of the S A Council for Scientific and Industrial Research - an initial statement* was published and distributed in December.

The statement outlined the Council's plans for establishing national scientific laboratories to undertake long-term research and contract investigations for industry. An important issue covered in the statement was the duty of the CSIR to promote research at universities through grants and bursaries. The Research Council Bill which was passed by Parliament also made provision for the CSIR to liaise between South Africa and other countries in matters concerning scientific and industrial research. Scientific and technical co-operation on a global level was promoted by the CSIR through its membership of the International Council of Scientific Unions (ICSU) and its member unions for which South African national committees were established.

Development of the physical sciences

One of the first institutes of the CSIR was the National Physical Laboratory (later called the National Physical Research Laboratory) which was modelled along the lines of the National Physical Laboratory in the United Kingdom. Dr S M Naudé, who later became President of the CSIR, was appointed its first Director and he established a number of divisions, several of which later grew to become independent institutes, such as the Electronics Division which became the National Electrical Engineering Research Institute.

The National Physical Research Laboratory was charged with establishing and maintaining the fundamental standards of mass, length and time, and over the years has provided industry with an extremely important service, which was later called the National Calibration Service.

The establishment of an Atmospheric Physics Division within the National Physical Research Laboratory illustrates again the value of far-sighted enlightened scientific investigation.

The Laboratory became interested as early as 1954 in the fundamental concepts of atmospheric pollution. The theories and measuring equipment that were developed as a result had a profound effect on the knowledge which was passed to industry and the public authorities. Today research into atmospheric physics in South Africa is considered amongst the most advanced in the world.

The Nuclear Physics Division of the National Physical Research Laboratory established in 1948 grew remarkably

*Wrong,
X Separate
body establish.*

The CSIR – 40 years of research



Dr P J du Toit – President 1950-1952

rapidly. It built the first 17 MeV cyclotron in South Africa. The field grew to such an extent that the separate Atomic Energy Board (now the Atomic Energy Corporation) for research into nuclear energy was established.

Fundamental research in physics also led to many developments and applications in such areas as building acoustics, optical sciences and optical materials, spectroscopic analysis in industry and instrumental methods of analysis and testing in many different fields.

Chemical research

The National Chemical Research Laboratory has played a major role in the growth of chemical research in South Africa. The Chemical Engineering Research Group, which later functioned as an independent group, has made important contributions to South Africa's chemical industry.

Water treatment and the recycling of water were first studied at the National Chemical Research Laboratory, and later a separate institute, the National Institute for Water Research, was created for this field of study.

In the field of food technology, earlier chemical work eventually led to the establishment of the National Food Research Institute. This institute has made major contributions to the understanding of nutritional diseases and other nutritional problems.

Engineering sciences

The engineering institutes grew generally from divisions within the fundamental institutes. The three major engineering fields are electrical, mechanical, and chemical engineering. Civil engineering does not have a separate institute, but is studied at various institutes.

In electrotechnology the National Electrical Engineering Research Institute has developed special techniques for measuring lightning and overcoming the problems that it creates with high-voltage power transmission lines. Other fields where electrical engineering has been of assistance to South African scientists and engineers has been in micro-electronics and the design and production of integrated circuits and transistors.

In mechanical engineering major advances have been made in the understanding of rockbursts and other problems in geomechanics. In the study of air-conditioning and refrigeration, research findings have been applied in, for example, the mining industry and abattoirs. The use of carbon fibres and other mechanical devices for biological applications has also attracted world attention.

In the field of chemical engineering advances in catalytic processes for the liquification of gases have been made and the battery activity of manganese dioxide has been studied to assist industry.

Building

The National Building Research Institute has made many important contributions to the South African building industry. Low-cost housing and self-help techniques were developed to aid under-developed groups. Very important work has also been done on building on expanding soils and sandy soil masses, the use of blast-furnace slag in the manufacture of cement and bricks and the design of special buildings such as schools, hospitals and houses for the aged.

The CSIR – 40 years of research

Roads and transportation

In the area of road construction and engineering, the National Institute for Transport and Road Research developed from the Bitumen Binding Research Group. Specialized techniques of road compaction and road engineering in unstable soils have been studied, and road safety has also received attention. To study the long-term effects of heavy vehicles on roads, a highly efficient heavy vehicle simulator was developed.

Industrial research institutes

Based on a system of funding research for those industries that could organize themselves into groups, the CSIR has assisted the leather industry, the sugar milling industry, the fishing industry and the paint industry. Apart from the financial support based on equal contributions by the CSIR and industry, the CSIR has been able to support the fundamental sciences and engineering through its industrial research fellowships which were designed to encourage industry to do its own research.

The South African Inventions Development Corporation was formed specifically to cater for the need to patent and develop inventions by South Africans. A number of successful inventions have been valuable earners of income and have made contributions to technology world-wide, e.g. the 'Tellurometer' system for measuring distance.

The South African Wool and Textile Research Institute was established to cater for the needs of the textile industry. It has made advances in the treatment of textiles and has studied the use of wool and other fibres such as cotton and synthetics in textile technology.

The mathematical sciences

The National Research Institute for Mathematical Sciences was an off-shoot of the National Physical Research Laboratory. Advanced fundamental work in the field of mathematics is done by the Institute and the knowledge is used, amongst other things, for solutions to industrial problems. Mathematical techniques including systems analysis have proved to be of considerable value to other workers even in the more applied fields of R & D.

A natural development from mathematical research was the establishment of the Computer Centre. Early studies were done at the National Electrical Engineering Research Institute on analogue as well as digital computers. An institute was eventually founded for specifically maintaining a number of computers for use by the CSIR as well as other organizations throughout South Africa.

Astronomy, geomagnetism and telecommunications

The observatories of South Africa have won acclaim even from the early days, in fact ever since 1820 when the Royal Observatory was established in the Cape. The CSIR



Dr S M Naudé – President 1952-1971

was given the task of reorganizing South Africa's observatories into the South African Astronomical Observatory with its observing station at Sutherland in the Karoo.

The Magnetic Observatory at Hermanus has also played a significant role in providing data for fundamental research on the magnetism of the earth as well as studies of the ionosphere in the southern hemisphere.

The National Institute for Telecommunications Research has made important contributions towards distance mea-

The CSIR – 40 years of research



suring. The 'Tellurometer' system mentioned previously has revolutionized distance measurements on earth by providing an extremely accurate and precise method. This Institute is also responsible for radioastronomy at the Hartbeesthoek radio telescope north-west of Johannesburg. The Institute collaborates with other countries in the field of satellite research and remote sensing experiments using satellites.

Scientific and technical information

From the very beginning it was realized that the provision of information and library services would be a fundamental requirement of any scientific and technological programme. In the early planning of the CSIR, provision was made for the establishment of a technological information centre. This centre has grown from the original library to the National Institute for Informatics which includes not only library facilities for the whole country in the field of science and engineering but also provides information services in the form of data banks and access to literature all over the world.

International liaison

The early planners of the CSIR recognized the importance of international collaboration. The first overseas office was opened in London, and later offices were opened in Washington, Cologne, Paris and Los Angeles.

Dr C van der Merwe Brink – President 1971-1980

Funds

Review of development from 1945 to 1984

It is important for the sustained economic growth of any country to invest money in scientific and technological research. The total expenditure of the CSIR of R1 139 million since its establishment in 1945 resulted in it becoming a leading national research facility with extensive research programmes for the benefit of South Africa. A substantial proportion of the funds has been used from the beginning for the support of research at South African universities and other research organizations and for the development of scientific and technological manpower in South Africa.

The initial continual growth (diagram 1) was influenced after 1956 by the periodic incorporation of other organizations, the splitting off of activities, very small increases in parliamentary grants in some years, and changes in the income from other sources. The further increase in the expenditure after 1980 was chiefly due 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.

The total expenditure of the CSIR levelled off after 1966 at approximately 0,21 per cent of the gross domestic product (GDP) (diagram 2), and therefore maintained a relatively small constant relationship to the country's economic activity, despite the increase in the contribution of the manufacturing and infrastructural sectors to the GDP from 38,7 per cent in 1966 to 40,7 per cent in 1984, and despite the growing importance of technology for economic and other developments.

Total expenditure and income

Although the total expenditure of the CSIR on current items and fixed assets increased by 15,8 per cent in 1984/85, the real increase (after allowing for inflation) was only 2,3 per cent. The low increase, after the transfer of the National Institute for Personnel Research to the Human Sciences Research Council, was used almost exclusively for the further provision for improved conditions of service, as well as for the expansion of a few research activities. Sufficient funds were therefore not available to provide adequately for the effects of unfavourable exchange rates on the prices of imported consumable items and laboratory equipment. The curtailment of many research and other activities was therefore unavoidable.

Investigations and services (26,3 per cent of the total income, with a real increase of 7,9 per cent) again provided an important source of income (diagram 3). Contract research (120 projects) and 2 576 other scientific and technological services (630 specialized tests, 923 requests concerned with instrumentation, 143 detailed investigations and 880 other services), as well as 8 500 computerized literature searches and 120 000 copies of documents

were carried out for or provided to a large variety of government institutions, the private sector and other research institutions.

The *parliamentary grant* (68,5 per cent of the total income of the CSIR with a real increase of only 1,2 per cent since 1983/84) is used for the acquisition of knowledge and know-how, as well as for the development and provision of technological infrastructure and services. This work provides the basis for continued technological innovation (especially by the South African manufacturing industry), the maintenance and improvement of the quality of life, the conservation of the environment, the utilization of available resources, the overcoming of resource deficiencies, and support for the general advancement of research and science in South Africa.

Running expenditure

Staff remunerations (salaries, wages and allowances) was again the largest part (65,9 per cent). The real increase of 5,6 per cent since 1983/84 was chiefly the result of the improvement in service conditions mentioned above to eliminate remuneration arrears (backlogs) relative to other sectors.

The increase in *grants and subsidies* to 8,9 per cent of all running expenditure indicates increases in the support for basic and non-directed research projects at universities, technikons and museums and in grants for research with specific national objectives at universities and other research institutions. Specific research by and for industry was again supported.

Capital expenditure and income

The increase of 1,7 per cent in the real expenditure on *laboratory equipment* (59,5 per cent of the total fixed asset purchases) does not reflect an increase in actual physical purchases. Unfavourable exchange rates led to price increases which were much higher than the GDP inflation rate (used for calculating real equivalents), and this resulted in a decrease in the physical purchases which could be made with available funds. Increasing shortcomings in the equipment for many essential activities are already evident.

Activity pattern of the CSIR

The largest portion (69,6 per cent) of the CSIR's own expenditure is used directly or indirectly for research and development (R&D) and the remaining portion (30,4 per cent) for other scientific and technological activities.

The latter is chiefly directed towards the creation of the essential R&D infrastructure of the country and also the provision of services for non-research purposes. The most important activities in this regard were *information and documentation* (39,1 per cent of other scientific and technological activities), specialized *testing, standardization*

Funds

and quality control (24,8 per cent) and advisory services (19,4 per cent).

With regard to the allocation of the R&D expenditure to various research fields (or disciplines), the largest components were again *engineering sciences* (31,3 per cent of the R&D), *physical sciences* (24,7 per cent) and *technological sciences* (17,0 per cent).

Considerable attention is given by the CSIR to those sciences that are essential for the technological development of South African industry and infrastructure.

This is reflected in the total expenditure on R&D according to the expected use of the results by specific socio-economic sectors (diagram 4). The largest contributions were for the *manufacturing sector* (21,5 per cent of R&D) and *community development* (38,2 per cent). *Other economic activities* (14,7 per cent), *development of the infrastructure* (13,2 per cent), and *general advancement of knowledge* (12,4 per cent) were also supported.

Diagram 3: Actual total income 1975/76 - 1984/85

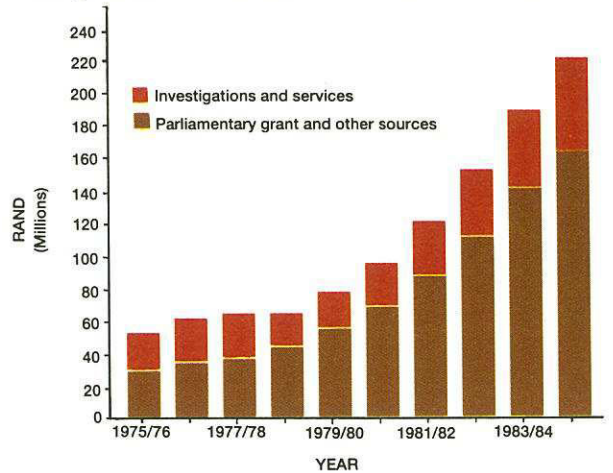


Diagram 1: CSIR expenditure 1945/46 - 1984/85

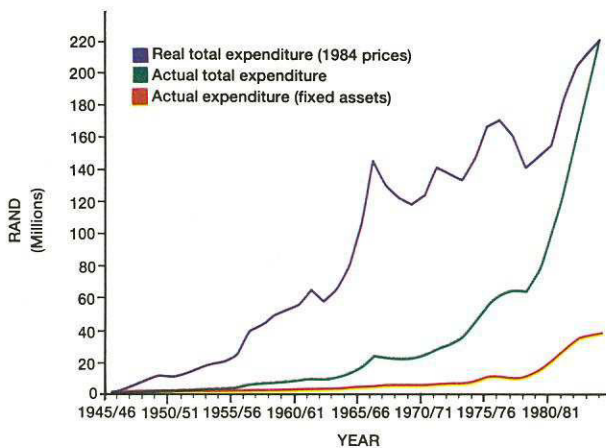


Diagram 4: R&D expenditure by socio-economic sector

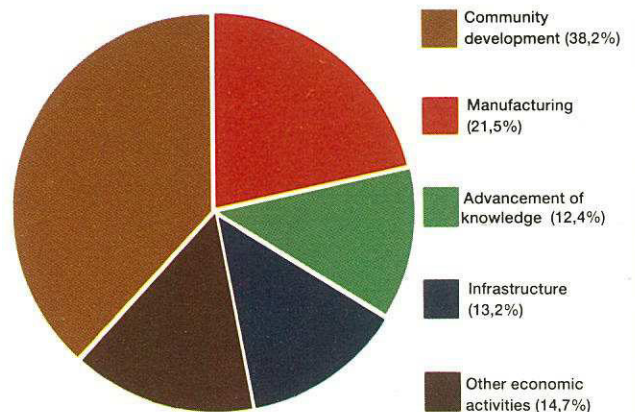
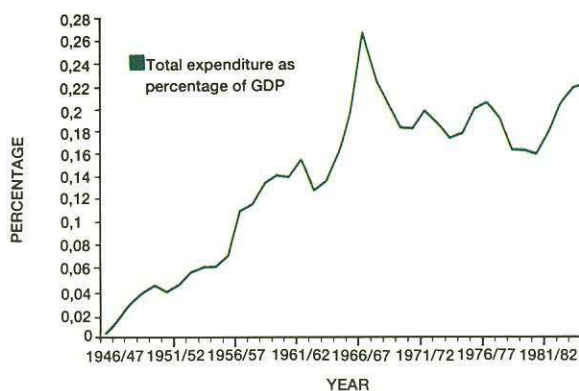
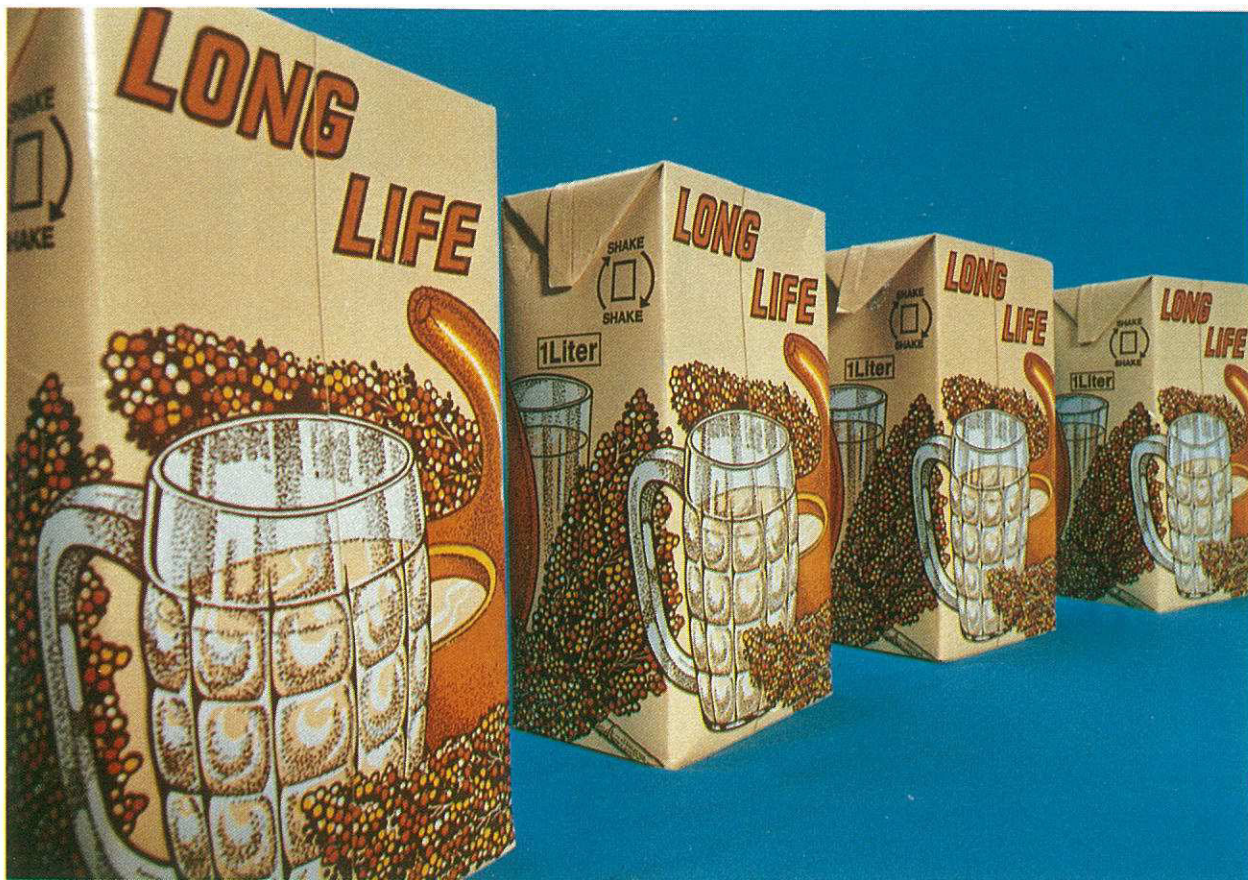


Diagram 2: Relationship of total expenditure to GDP 1945 - 1984



An intensive two-year development programme conducted by the Sorghum Beer Unit of the CSIR, a brewery in Potchefstroom and a packaging company has led to the marketing of a new sorghum beer. The new method consists of full fermentation and pasteurization of the beer before it is packaged aseptically, and eliminates the disadvantages of a very limited shelf life and inconsistent quality of conventional sorghum beer. Extensive consumer research showed that a low-alcohol, home-brew type product which was essentially a still, fully fermented beer was popular. A 100-litre pilot plant was installed at Tlokwe two years ago and once the brewing process had been perfected and an acceptable product created, full production using the aseptic packaging system was started.



Effect of antinutrient in soybeans

A joint research project on the antitryptic effect of soybean products was carried out by the National Food Research Institute and a visiting expert from an American university. In contrast to rats, the baboons which were used as experimental animals showed no signs of pancreas enlargement even after five months on a diet with a relatively high antitrypsin content.

As in other Western countries, the consumption of textured soybean products is also increasing in South Africa. The raw bean contains considerable quantities of a so-called antinutrient which inhibits the action of the digestive enzyme trypsin.

Although the antinutrient is destroyed by the cooking process, the antitryptic action is often present to a certain extent in heat-treated soybeans. Feeding tests on rats showed that relatively low concentrations of this factor in the diet affect the pancreas. The question is therefore whether long-term intake of the antitryptic factor would also be harmful to primates.

According to the results of tests done at the Institute, baboons which were given a diet with a fairly high antitrypsin content for five months showed no signs of pancreas enlargement.

The composition of plant oil mixtures

The National Food Research Institute developed a mathematical model for objectively evaluating the results of chemical and physical analyses of plant oil mixtures.

Various plant oils, according to their specific properties, are used in food and by the paint and steel industries. For this reason, and because the market values of oils differ greatly, the industrial user must be able to determine the identity of an oil or an oil mixture with absolute certainty.

Since the mathematical model was developed, a large number of pure samples of sunflowerseed, soya, cottonseed, peanut, maize and other oils have been analysed. Three groups of compounds, namely fatty acids, sterols and tocopherols, in which altogether 38 separate compounds are represented, were identified in the samples. To test the model, 93 different oil mixtures of known composition were prepared and analysed. It was found that the composition of the mixtures could be determined more accurately with the mathematical model than by subjective evaluation of the analyses.

Ground water in the Springbok Flats

The National Physical Research Laboratory undertook an extensive nitrogen isotope and chemical investigation to determine the cause of the high nitrate concentration in the ground water over a large area of the Springbok Flats.

It was found that the high nitrate concentrations, which exceeded the recommended health limit for human con-

sumption, were due to accelerated mineralization of organic nitrogen in the black clayey soil. This is a result of increased agricultural activity over the past 50 years - a process that is still continuing. It also appears that ground water of low and high nitrate concentration is becoming mixed in the water-bearing structures so that boreholes which previously yielded acceptable levels of nitrate are becoming contaminated.

The prognosis is that the loss of nitrates from the soil to the underlying ground water will lead not only to contamination of the water but also to impoverishment of the soil, rendering it increasingly infertile.

Removal of sulphate from industrial effluent

The National Institute for Water Research developed a biological process for removing sulphate from mining and industrial effluent which involves the addition of molasses. With the aid of an anaerobic and a photosynthetic reactor the sulphate is first converted to hydrogen sulphide and then to sulphur.

Mines and other industries are being compelled to reuse water owing to the increasing scarcity of fresh water. Their effluents are often saturated with calcium sulphate and contain high concentrations of cyanide and heavy metals, which make them unsuitable for reuse or disposal into public waters.

The process is economically feasible since sulphur to the value of R0,32 may be produced from 1 m³ of effluent saturated with calcium sulphate, and molasses to the value of only R0,24 is required. Price increase trends for the past five years indicate that the process is likely to become even more economical in future. The prices of water and sulphur, the final products of the process, have increased by 116 and 633 per cent respectively, compared with only 34 per cent for molasses.

The process has been tested in the laboratory and several mining groups are planning pilot scale development.

Both sulphur and water are key production factors in the South African economy and 50 per cent of our sulphur is still being imported.

Training of water treatment technicians

At the request of various organizations with interests in the training of technicians for water and waste water purification plants, the National Institute for Water Research compiled a guide entitled *Manual on Water Purification Technology*.

The course for the National Diploma in Water Care, which is what the guide is mainly for, is currently offered by only four technikons. The Department of Water Affairs' regulations concerning persons employed at water and waste water treatment plants published in December 1985 will undoubtedly create a demand for more training facilities.

Laboratory reactor for fuel production

A laboratory-scale high-pressure reactor with internal gas recirculation for the evaluation of catalysts was developed by the Chemical Engineering Research Group. The catalysts studied are used for the conversion of synthesis gas obtained from coal to liquid fuels.

The performance of the laboratory reactor is superior to that of commercial models. Researchers can now realistically simulate a variety of industrial reactors with the new apparatus.

A number of the reactors were made by the Technical Services Department of the CSIR for university and industrial laboratories. The design is also being used overseas.

Rapid classification of coal

The National Institute for Coal Research developed a rapid method for the classification of coal. The method is based on the finding that the dry ash-free heating value and volatile content of coal can be correlated with its element composition, certain physical properties and its petrographic and coking properties. Coal can therefore be characterized and classified on the basis of limited analyses of drill cores.

The rapid classification, which is simpler than the usual complete analysis, can be used to give a general indication of the possible uses of a particular type of coal.

Characterization of the mineral components of coal

X-ray diffraction techniques were optimized by the National Institute for Coal Research for accurate analysis of amorphous clay, lesser-known minerals and minerals which previously could not be quantitatively determined.

A library of calibration curves of the minerals that typically occur in South African coal is at present being compiled with the aim, amongst other things, of relating coal from various layers and geographical regions to coal geochemistry.

Integral solar water heaters

An investigation in terms of the National Programme for Energy Research on the use of integral solar water heaters in the houses of low-income families showed that a surprisingly large proportion of these families' incomes (6 to 14 per cent) was spent on energy.

The performance of 100 integral solar heaters in low-income houses was monitored for a year, and it was found that this type of solar heater used as a pre-heater for an electric unit did not lead to a significant saving. However, despite the disadvantages (no hot water early in the morning or late at night), the consumers were generally prepared to use the integral solar heater as the only water heater in view of its low cost and other advantages.

Alternative diesel fuels

A number of alternative diesel fuels were tested by the National Mechanical Engineering Research Institute for the Division of Transportation of the National Programme for Energy Research.

Research is continuing on light diesel fuels and fuel supplements with a view to preventing an imbalance in the use of diesel fuel and petrol. Tests with one of the alternatives, a light diesel fuel, showed that the harmful effect of the fuel on a particular diesel engine can be partially eliminated by altering the injection timing to compensate for its non-ideal combustion properties. Other aspects, such as engine wear and corrosion are being investigated.

The Institute also undertook a project to evaluate 'diesanol' (methanol with an ignition improver), a fuel manufactured from coal as a diesel substitute, for the Department of Mineral and Energy Affairs. The effect of the mixture was tested on a large diesel engine and it was found that although standard diesel engine parts were suitable in most cases, some parts, especially those involving the injection equipment, would have to be modified. Research is continuing on the development of more durable materials for those specific parts. The matter of a suitable lubrication oil is also receiving attention.

Research on methanol-based fuels is regarded as important as methanol can be obtained from coal as well as natural gas.

Alternatives to fossil fuel

The findings of an investigation carried out in terms of the National Programme for Energy Research (Transportation Division) were presented in a paper read by three CSIR staff members. It was predicted, amongst other things, that at the present accelerated rate of consumption, South African coal reserves will not be sufficient for requirements in the next century, and that the demand will already have exceeded the supply by 2015.

According to the authors, the saving of coal in the longer term is a matter of great importance. Greater attention will therefore have to be paid to the use of electricity in the transport sector and the production of electricity by nuclear fuel instead of coal.

Fine coal beneficiation

Great success was achieved with a fine coal beneficiation process developed at the University of Cape Town under the auspices of the National Programme for Energy Research.

Pilot plant flotation cells were installed at four major collieries. Results showed that 80 per cent of the fine material which is currently discarded can be recovered and added directly to export coal. A full-scale recovery plant with a capacity of 100 tons per hour is now being designed.

Essential standards for low-income housing

As it is believed that housing of acceptable quality can be built to more appropriate and affordable standards which take local conditions and preferences into account, the National Building Research Institute is investigating means of deriving such standards.

It has been clear for some time that it will hardly be possible to make up the large housing backlog which is being caused by rapid urbanization, especially of the Black population of South Africa, if First World standards are applied to housing for people in the low-income group.

On the basis of the Institute's proposals so far, the Agrément Board of South Africa has introduced a special certification system (MANTAG) which can be applied to the building of cheap, simple, free-standing houses and related buildings in designated areas in which the National Building Regulations are waived by special application to the appropriate Minister. The Department of Development Aid and the Department of Public Works have already endorsed this system.

More solid roof construction

The National Timber Research Institute, in collaboration with the South African Bureau of Standards and other interested parties, found that inadequate bracing of roof trusses is the largest single cause of structural defects and failure of timber roof structures.

A method for the design of roof trusses was developed by analytical techniques. It is expected that this development will revolutionize the design of trusses, thus increasing the reliability of timber roof structures and lowering costs.

The National Building Research Institute (NBRI) is currently formulating design criteria for the provision of special accommodation suited to the needs of old people.

A unit was designed to suit elderly couples or singles, healthy or handicapped, and is intended to provide them with a permanent home right up to the point where they require 24-hour nursing. The design also obviates, in the case of death of one of the occupants, the need for the survivor to move out.

Specially designed fittings and a more rational use of space has made it possible to provide acceptable living units with a minimum floor area of only 35 m², which can easily be increased without reducing the design quality of the unit. Up to two powered wheelchairs can be accommodated.

The primary aim of the research project was to design in one common structure a functionally acceptable unit of accommodation which can cater equally for fit, handicapped or frail aged persons and couples. It should be capable of satisfying the requirements of changes in their economic and physical state without exceeding the cost and space limitations of officially prescribed standard housing for the aged.

Photo: This basin, patented by the NBRI, is hydraulically operated and can be adjusted to any height between 730 mm and 1 150 mm.



Search for improved steroid hormones

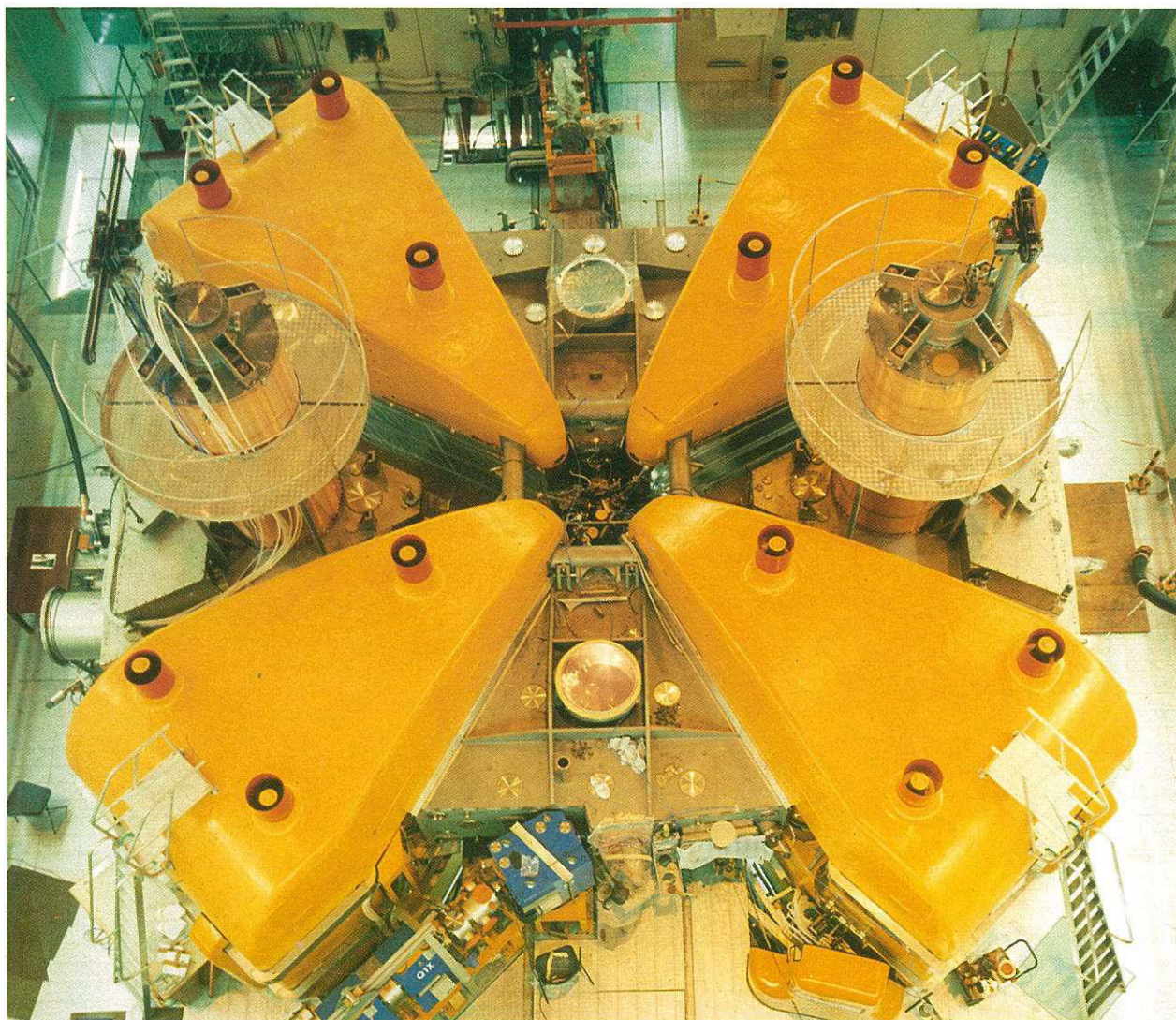
Considerable progress was made by the National Chemical Research Laboratory with the preparation of new steroid hormones that can be used for the development of pharmaceuticals. The total synthesis of a series of modified steroid hormones has been completed.

The aim of the investigation is to determine the influence of spatial deformation and mobility on physiological activity. The compounds concerned contain groups which cause spatial over-occupation and whose interaction can only be reduced by spatial change of form of the compounds. The results of biological tests have confirmed that some of the compounds can act as steroid hormones.

Toxins of the blue-green alga

Several variants of the dangerous toxin which is secreted into dams by the blue-green alga *Microcystis aeruginosa* were isolated and purified by the National Chemical Research Laboratory, and their structure determined. Mice were immunized with the toxin and a monoclonal antibody was prepared by the hybridoma technique.

The new separated-sector cyclotron of the National Accelerator Centre seen from above. The four sector magnets and the radio-frequency resonators (the two tall structures on both sides) are shown. The cyclotron has a diameter of more than 13 m and is more than 7 m high.



An antibody-linked, enzyme-based method is being developed for the determination of low concentrations of the toxin in water.

Toxic plant constituent

After a serious outbreak of skin infection at a school, new research was started on the blister-causing component of the plant *Smodingium argutum* by the National Chemical Research Laboratory in collaboration with researchers of the Medical University of Southern Africa and the Botanical Research Institute.

The most important active constituent of the plant was isolated in pure form for the first time, and its chemical and biological action is being investigated.

Determination of lead concentration in city air

The National Physical Research Laboratory investigated methods of determining the lead concentration in the air over cities. It is suspected that vehicle exhaust gases are the most important source of lead pollution of the air, but before the authorities can decide on the permissible lead content of petrol they must have reliable information.

Late in 1983, 600 petrol samples from around the country were analysed for lead content. A follow-up study was made in 1985. Such studies will be repeated in order to relate the changing nation-wide pattern of lead use to observed air pollution by lead. A cheap method of mapping lead concentration in the air in urban areas was developed: hundreds of samples of jacaranda leaves from various parts of Pretoria were analysed to determine how much lead (and other elements) had been deposited on the surface of the leaves. According to the results, this method gives a good indication of lead concentrations in the air. More accurate but more costly samplers can be optimally positioned according to maps compiled on the basis of this system.

Identification of pollutants in the atmosphere

The National Physical Research Laboratory started a programme to determine which organic pollutants are released into the atmosphere by the most important sources of pollution, including the country's industries.

Our lungs are exposed to many potentially harmful organic pollutants, for example motor vehicle exhaust gases, chemical effluents from industrial processes, gases from coke ovens and coal stoves, and evil-smelling products from chicken and pig farms. To determine the risk of pollution in each case, the many compounds must be separated, identified and measured. The Laboratory has already separated and identified hundreds of pollutants in these compounds by gas-chromatographic and mass-spectrometric techniques. Some unusual substances were traced in this way to specialized processes at certain points in industrial plants.

The Laboratory extended its research programme to include urban areas and is attempting to develop methods for the early identification and control of potentially harmful substances to protect the community.

Commissioning of hospitals

A senior member of the hospital research group of the National Building Research Institute and a senior operations researcher from the National Research Institute for Mathematical Sciences were members of a multi-disciplinary team sent to the United Kingdom to obtain information on the commissioning of hospitals.

In the United Kingdom an advanced planning system for health care services was developed over a period of time, and standard procedures and norms were drawn up for the selection and purchase of hospital equipment. Guidelines of this nature, adapted for South African conditions, can prevent an unnecessarily large percentage of the total building costs of a hospital being spent on equipment. The National Building Research Institute has since compiled a comprehensive report on the subject.

The National Research Institute for Mathematical Sciences is now collaborating closely with the commissioning team for the new Groote Schuur Hospital in the application of operations research techniques to resolve problems of planning the commissioning schedule.

Traffic noise

The National Institute for Transport and Road Research completed its comprehensive investigation into the control of traffic noise on roads, for which funds had already been made available by the Department of Transport in 1981.

It was confirmed that the British method of predicting traffic noise, which had been recommended earlier, was the best for adaptation to South African conditions.

The South African Bureau of Standards is incorporating the Institute's findings in a code of practice which should contribute greatly towards effective control of traffic noise. The Institute is compiling a guide to the role of road design as a way of reducing noise.

Optical night viewing system

The Optical Sciences Division of the National Physical Research Laboratory developed a new concept which allows lenses of extremely large aperture to be designed while using only four optical elements as compared to up to nine elements required in conventional techniques.

Other features of the new design add to the cost-effectiveness of manufacture. These include the fact that the lens is relatively insensitive to the location of the aperture stop which can in many cases be placed at the first optical element, thus reducing its size and hence the cost of the optical materials used. As the new lens is also inherently insensitive to manufacturing errors it can be produced relatively cheaply compared to conventional optical systems.

Such lenses are suitable for night viewing equipment which enables the observer to examine the surroundings by starlight. To function effectively, the equipment must have special lenses that can gather as much ambient light as possible.

Emergency signal flares for the export market

A Cape Town manufacturer of flares for emergency signals and similar purposes requested the National Physical Research Laboratory for assistance with improving its manufacturing and measuring procedures. The Laboratory is the only institution in the country equipped with measuring equipment suitable for this purpose.

Experts from the Laboratory did a series of tests and made recommendations which will equip the company to carry out the necessary intensity and colour measurements accurately enough to make their product acceptable for the export market.

Operations research for banking

A number of asset-liability models which can be applied to various banking situations were developed by the National Research Institute for Mathematical Sciences and programmed for computer. One of these models was linked into the financial data base of a commercial bank to help the management in policy decision making.

Tribological investigations

A visit to a manufacturer of fuel injection equipment in the United Kingdom has led to a decision that the tribological investigation of the company's injection units would henceforth be carried out in South Africa by the National Mechanical Engineering Research Institute. Previously equipment for testing South African fuels had to be sent back to the manufacturer, and it often took eighteen months to obtain the results.

The first consignment of fuel injection units has already been tested by the Institute. The equipment was tested in the laboratory with various Sasol diesel fuels and lubrication additives, and the results were quickly available.

Diamond machining of multi-faceted reflectors

The Production Engineering Advisory Service at the National Mechanical Engineering Research Institute succeeded in manufacturing efficient optical reflectors from metal by diamond machining. This type of reflector was previously imported because South Africa did not have the required machining facilities.

Initially a standard workshop lathe was used as diamond lathes are very costly. However, the standard lathe has certain mechanical limitations, and therefore a fair amount of time was spent on determining the most effective diamond tool geometry.

Accurate reflectors 75 mm in diameter and with a concave radius of 150 mm have been produced with the available equipment.

After the workshop lathe had been used to its fullest capacity, the development of a diamond lathe was continued, and it has now already been used to make South Africa's first multi-faceted reflectors. Optical reflectors can be made much faster and more accurately by diamond machining than by conventional methods.

Portable data collection unit

A powerful and versatile portable data collection and control unit developed by the National Electrical Engineering Research Institute aroused much interest. A large number of the units were adapted for a great variety of applications, and improvements were also made to increase their usefulness and reliability.

A good example of the application of the apparatus is the checking of water quality based on the microcalorimetry of enzymes. This system, which was developed in collaboration with the National Institute for Water Research, can be used for monitoring factory effluent which can pollute dams and rivers.

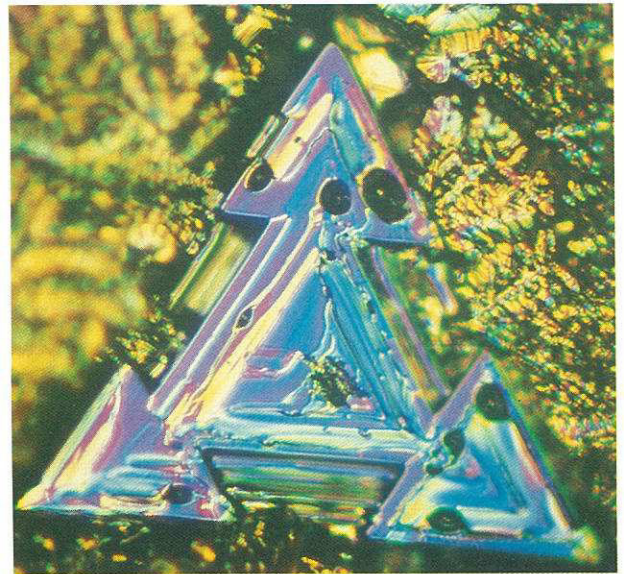
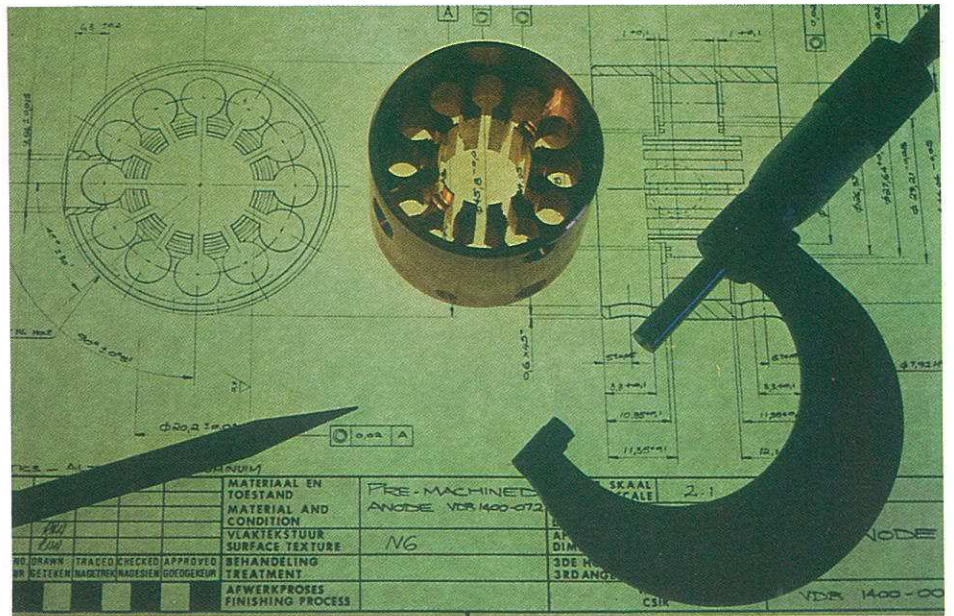
An article on the unit appeared in the journal *South African Measurement and Control* and two papers on the water monitoring system were read at international conferences.

Computer integrated manufacturing and robotics

The National Electrical Engineering Research Institute is involved in research on computer integrated manufacturing and robotics. The aim is to find solutions to the problems encountered by manufacturers of high-technology electronic products when small batches have to be manufactured.

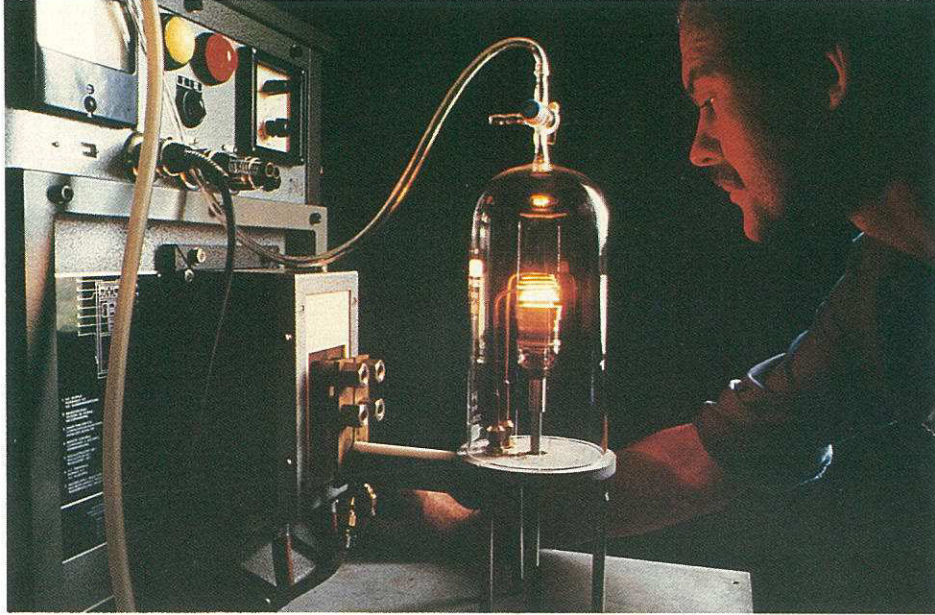
A programmable scanner for testing unmounted printed circuits and an infrared diagnostic station for testing mounted printed circuits were developed. The two systems are already being used to test small batches of printed circuits.

The CSIR provides industry with complete technology packages including detail design documentation: this is an example of work done by the National Institute for Materials Research.



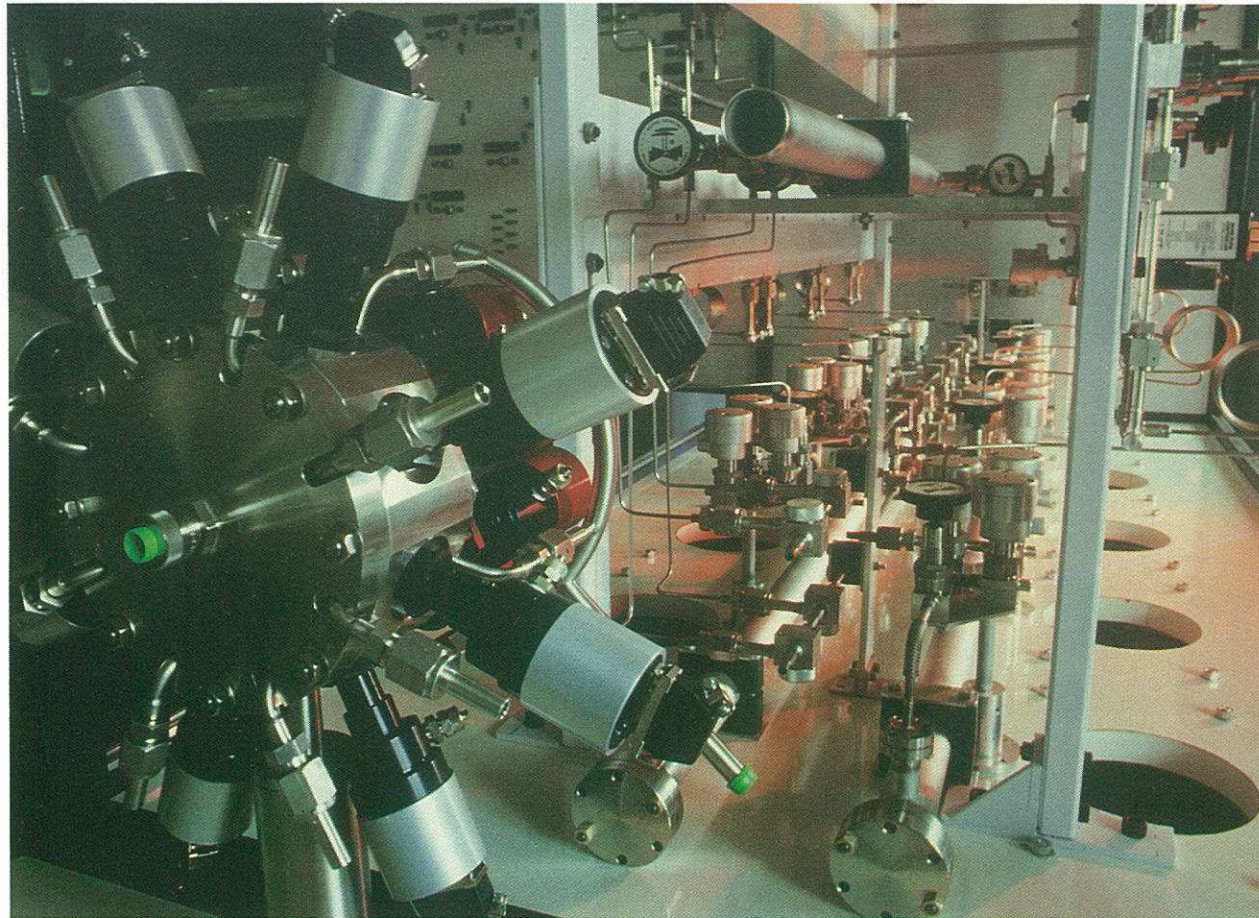
Hg_{1-x}Cd_xTe crystal spontaneously nucleated from a saturated solution of Hg and Cd in Te as part of research on this material at the National Institute for Materials Research.

View of the four-storey-high slurry reactor recently constructed at the Chemical Engineering Research Group. Slurry reactors are an attractive alternative to the fixed-bed or entrained-bed reactors currently used by Sasol for the Fischer-Tropsch synthesis of fuel. The aim of the project is to obtain reliable hydrodynamic data for slurry systems so that large-scale reactors can be designed with confidence.



The activities of the CSIR span the range of fundamental research to applied technology – an electronic device is being fabricated using an induction heated soldering step at the National Institute for Materials Research.

Organo-Metallic Vapour Phase Epitaxy reactor for growing ultrathin layers of gallium arsenide semiconductor crystal in atom-for-atom registration on a single crystal substrate (National Institute for Materials Research).



Short production route for woollen yarn

The South African Wool and Textile Research Institute found that the process known as the woollen system, which until now was the shortest process for the manufacture of spun yarn, could be shortened even further.

By attaching hollow spindle units to the delivery side of an ordinary woollen card machine so that the slubbing is surrounded by a fine synthetic filament, researchers at the Institute succeeded in manufacturing yarn which is strong enough to be woven just as it is. In this way the conventional spinning process is eliminated.

The process has aroused interest locally and abroad and is being further evaluated.

Weavability of worsted yarn

The South African Wool and Textile Research Institute is developing a measuring apparatus for the rapid location of isolated weak spots in worsted yarn.

After thorough investigation it was found that weak spots in the yarn are the most important of the variables that affect the weavability of worsted yarn. This investigation was possible due to the modern methods of computer analysis available to the CSIR.

Suspension casting of white cast iron

The National Institute for Materials Research succeeded in applying the process of suspension casting (micro-chilling) to the production of white cast iron.

White cast iron is an alloy with good abrasion resistance but limited impact resistance. Normal casting processes do not always give an alloy with the desired properties - for example, shrinkage defects and non-ideal phase morphologies can occur in castings.

In the suspension casting process, alloy metal powder is added to the smelted iron. In this way a material with a refined microstructure is produced. This means that more widespread use could possibly be made of particular alloys with a high chromium content.

Surface composition of gallium arsenide

The National Institute for Materials Research determined, with the aid of X-ray photoelectron spectroscopy and ion microprobe mass analysis, that the surface layer of gallium arsenide contains, apart from free arsenic, six different gallium and arsenic compounds with oxygen. This information is used to optimize the preparation process of the gallium arsenide surface before the material is further processed in the manufacture of advanced electronic devices.

Better mercury cadmium telluride crystals

Mercury cadmium telluride crystals for use in electro-optic devices were prepared by recrystallization at the National Institute for Materials Research. The particle size of the crystal material obtained is only a few millimetres. Mercury

vapour treatment modifies the material to make it suitable for use in electro-optical devices.

If the process can be further refined, it should be possible to obtain crystals that are just as good as the imported material which is costly and difficult to obtain.

Manufacture of semiconductors

A reactor for the manufacture of most of the compounds in the class of semiconductor materials used for lasers, integrated high-speed circuits and electro-optical devices was designed by the National Institute for Materials Research and is already under construction.

These materials, which are used in the form of single crystals, are extremely important in modern communications systems and for computer technology. Thin layers with an extremely uniform composition and controlled electro-optical properties are grown by a vapour-phase crystal growth process.

Optical and electronic characterization techniques such as photoluminescence are used to determine the purity and electronic properties of the material.

Extraction of impurities from sugar cane

The Sugar Milling Research Institute investigated the effect of cane preparation, temperature and pH on the extraction from cane of total soluble solids (brix) and of a number of selected impurities, mainly colour bodies and colour precursors. A set of stirred vessels built at the Institute was used for the purpose.

This investigation has quantified the effects of temperature and pH both on extraction rate and on the final concentrations for the selected constituents. The results were evaluated according to two mathematical models, one describing the kinetics and the other the equilibrium properties of the cane-pulp/water system.

Crystal size distribution in C-masseccutes

The size distribution of sucrose crystals in low-purity products (C-masseccutes) was surveyed by the Sugar Milling Research Institute using a computerized image analysis system. An investigation was carried out concurrently at a few mills to evaluate the effect of the C-crystal size on the sucrose losses across the continuous C-centrifugals.

It was established that the passage of small sucrose crystals (up to 120 microns in width) through the screen perforations in the centrifugal accounted for most of the sucrose loss. A good inverse relationship was found to exist between the size of the C-crystal population and the sucrose loss at the centrifugals. As a direct result of the Institute's findings, the industry made a concerted effort to increase the size of sucrose crystals in low-purity products.

Hydrolysis and fermentation of bagasse

The Sugar Milling Research Institute was assigned the task of developing an enzyme-based process for the hydrolysis of bagasse.

Laboratory studies have shown that high molecular mass polyethyleneglycol (PEG) is as effective as polyvinylpyrrolidone (PVP) in increasing enzyme efficiency during saccharification of milled bagasse. The PEG and PVP were not effective when the substrate was pure cellulose. This suggests that these chemicals are effective in bagasse because they react with impurities which would otherwise react with the enzyme and reduce its efficiency.

The beneficial effect of the chemicals is decreased if the enzyme loading is increased to about 20 IU per gram of bagasse (53 per cent cellulose).

This project forms part of a national programme which is being co-ordinated and largely funded by the CSIR.

Bleaching process for furskins

The Leather Industries Research Institute (LIRI) has for some years been working with the International Karakul Secretariat based in Windhoek to develop bleaching methods so that Karakul furskins, which are mostly black, can be bleached to very light brown shades before dyeing to fashion colours. In the process of bleaching, the fibre pattern, lustre and strength must not be significantly altered.

LIRI has successfully developed a bleaching process which is now being assessed by the industry both locally and overseas.

Software for footwear manufacture

In collaboration with the Operations Research and Statistics Division of the National Research Institute for Mathematical Sciences, the Leather Industries Research Institute has started a major project on computer systems to aid footwear manufacture.

Software is being prepared for systems to give the most economical layout for cutting footwear components from sheets or rolls of material and for achieving the best cutting value of components from leather, which varies in shape and quality. These systems are vital for reducing component costs and avoiding wastage of materials. In addition, systems for production planning and computer-aided grading of footwear components to meet shoe size requirements are being prepared.

Modified atmosphere packaging of hake

Considerable commercial interest in modified atmosphere packaging (MAP) has led the Fishing Industry Research Institute to undertake extensive research into this method of preserving the quality of fresh fish, reducing bacterial counts and eliminating the formation of drip.

Several combinations of carbon dioxide, oxygen and nitrogen were used with hake fillets packed in varying gas-to-fish ratios. Air- or vacuum-packed samples were used as controls stored at 1 or 5 °C together with gas-packed samples. All samples were assessed by bacteriological, chemical and sensory methods of analysis.

In most cases, MAP extended the shelf life at 1 °C, in comparison with air- and vacuum-packed samples. The shelf life of MAP samples stored at 5 °C was not as long. Encouraging results were obtained regarding the bacteriostatic effects with higher levels of carbon dioxide. This advantage was, however, offset by a related increase in pack collapse, drip, and a deterioration in texture where carbon dioxide levels exceeded 40 per cent. Further research will have to be done to eliminate these deleterious effects.

Review

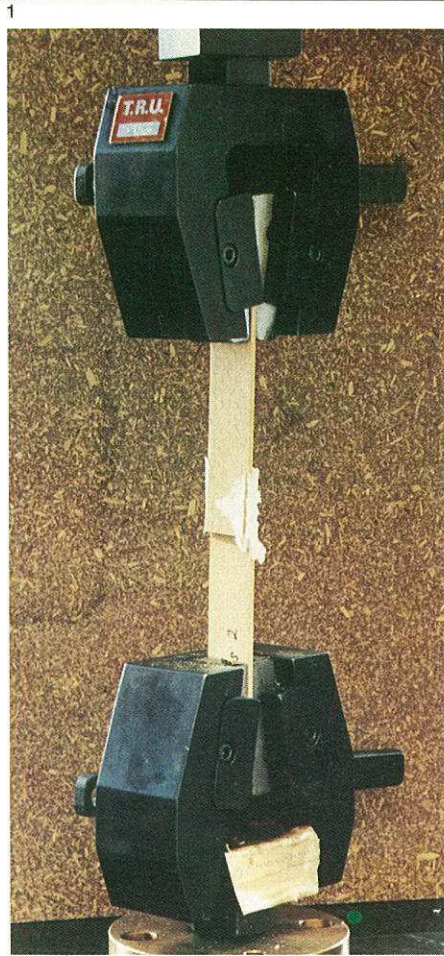
Industrial technology

1. Glazing of Mimosa-AI goatskin leather at the Leather Industries Research Institute. Glazing is an operation carried out on high-quality leathers to produce a high sheen with a natural appearance.

2. Evaluation by the Leather Industries Research Institute of bleaching methods suitable for naturally heavily-pigmented, black karakul pelts so that they can be dyed in lighter fashion shades without detriment to the wear properties and durability of the fur.

3. Finishing of goatskin leathers tanned by the Mimosa-AI process developed by the Leather Industries Research Institute.

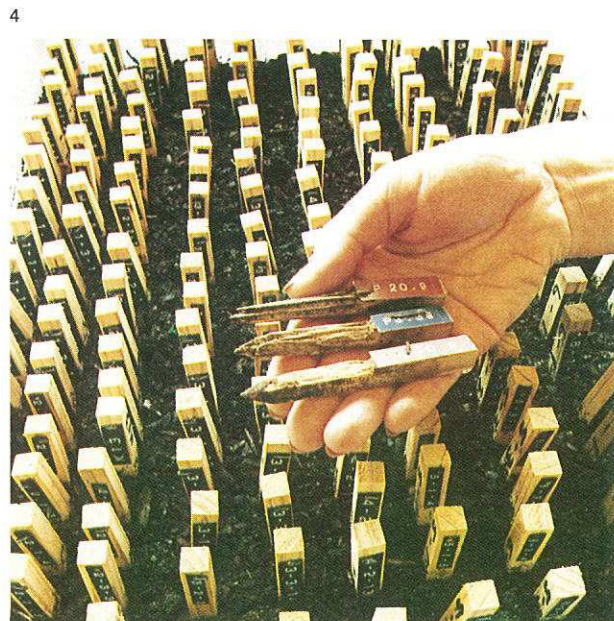
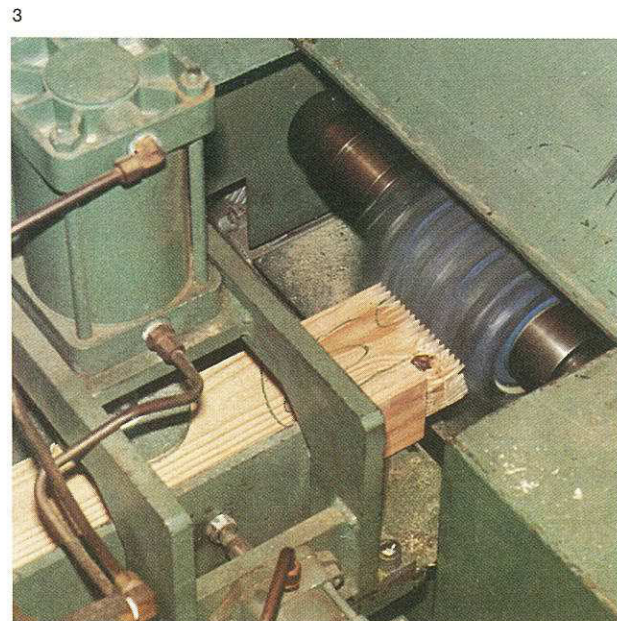




1. & 2. The strength of different glue formulations is tested at the National Timber Research Institute. Wood test strips are glued together and pulled apart using the test equipment shown in photo 1. A good glue should be stronger than the wood, and the strips should not part at the glue line. Photo 2 has captured the blur of movement as the test strip breaks.

3. Finger joints are important in the manufacture of glue laminated timber. Research on the subject at the National Timber Research Institute at present deals with finger profile designs to improve the strength of the joint.

4. Accelerated tests for wood preservatives were developed at the National Timber Research Institute. Small samples are used in the tests which predict quite accurately the effectiveness of new preservatives.



Breakwater, Table Bay harbour

The National Research Institute for Oceanology is engaged in a hydraulic model study to determine the best method of repairing and maintaining the western breakwater of Table Bay harbour which suffered considerable losses of armouring during the severe storms in May 1984.

The use of 40-ton Antifer cubes and 25-ton dolos units was investigated in a two-dimensional hydraulic model of the breakwater. The task was complicated by the lack of uniformity in the construction of the breakwater, parts of which are almost 100 years old.

Several surveys of the breakwater have been made, including profiling of the above-water slopes, hydrographic soundings of the nearshore areas as well as a side-scan sonar sweep and inspection by a team of divers of the underwater slopes.

Ship motion studies, Saldanha Bay

The National Research Institute for Oceanology has for some years been engaged in studies of ship motions in Saldanha Bay. These studies are concerned with the vertical motions of free ships, particularly large ore carriers. Problems related mainly to horizontal motions of moored ships are also studied.

The study of the motions of free-moving ships complements a similar study undertaken at Richards Bay. In addition to field measurements, physical and mathematical model studies are being carried out to predict the vertical motions of ships under extreme wave conditions.

The study of moored ship motions is concerned with the mooring of bulk carriers alongside the ore jetty. During adverse conditions, mooring lines often break and the horizontal motions of the ships become too severe. The jetty has been equipped with instruments to monitor extreme mooring conditions. Preliminary processing and interpretation of the data indicate that long-wave action is the major cause of the problems.

Prevention of scour damage to Mzinto bridge

At the request of the South African Transport Services, the National Mechanical Engineering Research Institute undertook a model study to determine what measures could be taken to protect the railway bridge over the Mzinto River on the Natal South Coast from scour damage.

After several possibilities were considered, it was recommended that a 120-m protection groyne should be built from the one bridge head into the lagoon to prevent the bridge from being washed away in a flood that occurs statistically once every hundred years. The costs of construction must be weighed against the costs for repair or replacement if the bridge and part of the railway line were to be washed away.

Design of bipolar high-voltage transistors

Two highly specialized bipolar high-voltage transistors were designed by the National Electrical Engineering Research Institute and are being manufactured on an industrial scale. Funds for the development of the transistors, which are used in telephones, were made available by the Department of Posts and Telecommunications. Approximately 2,5 million of the transistors have already been built into telephone instruments.

The first of the two products is a discrete transistor which meets stringent requirements for operating voltages and resistance to lightning surges. The second transistor, whose design shows particular inventiveness, led to the development of a unique integrated high-voltage double transistor of the Darlington type.

Research done during the development of these transistors led to additional developments such as a quality control procedure for the local manufacture of microelectronics components which was put into operation by the Department of Posts and Telecommunications for its own needs, and the design of a new high-voltage component with negative resistance to improve the resistance of electronic terminal equipment to surges induced by lightning.

Recycling of bituminous road material

As there is still doubt as to the cost advantages of recycled road paving material, the National Institute for Transport and Road Research developed a model for estimating the cost savings achieved by hot-mix recycling. With the aid of a reclamation plant, the 'Servacycler', which was designed and built by the Institute, the characteristics and performance of various recycled mixtures can be determined more accurately, and the quality of the mixtures improved.

The use of reclaimed asphalt (mixed in various proportions) for surfacing and basecourses is being investigated. Preliminary results indicate that high percentages of reclaimed gapgraded material can be used with new surfacing material to obtain continuously graded mixtures for bases.

Transport for Black commuters

An investigation by the National Institute for Transport and Road Research into commuter transport for Blacks (both in South Africa and neighbouring areas) indicated a surprisingly low volume (2.1 million trips per day during peak hours) as opposed to the high cost of approximately R2 billion per year. This amounts to R1 000 per commuter per year. The transport costs alone amount to approximately R1 billion a year, and R680 million is lost to time lost, R240 million to overloaded vehicles and crime, and some R70 million to accidents, insufficient infrastructure and crowded roads.

Commuting over distances greater than 30 km, and the fact that only certain transport modes on certain routes are subsidized, apparently also contribute greatly to the high cost. It was found that it costs at least R18 million per year less to transport commuters by jitney than it would to transport them by bus.

Moisture in road material

The National Institute for Transport and Road Research is involved in research on the effect and behaviour, as well as the influence of variables such as surface drainage, of moisture in roads.

It is known that the strength of any road material is greatly affected by its moisture content. Material in the dry state can be up to ten times stronger than when it is wet. In the past engineers accepted that sooner or later every road becomes saturated with water and that the material strength will then be that in the saturated state. However, on the basis of the latest findings, it is becoming accepted in some countries that the strength of non-saturated material can serve as the design criterion under certain circumstances. This means that thinner pavements can be designed and cheaper material can be used, which will lead to large cost savings.

In collaboration with the Department of Transport and the Provincial road authorities, the Institute took samples from roads throughout South Africa to delimit their moisture content and to determine the effect of variables. The effect of seasonal variations is being studied at present, and research is being done on the risk of failure where the strength of non-saturated material is used for calculations.

Waterbound macadam for road bases

The Department of Transport, in collaboration with the Natal Roads Department and the National Institute for Transport and Road Research, built and tested experimental road sections of waterbound macadam at Marianhill in the Pinetown area.

This granular construction material for road bases has been known for almost two centuries. Many of the old roads in South Africa are made of macadam and, especially in the wet areas of the country, have given particularly good service over the years.

There has recently been renewed interest in this type of paving material.

The results of tests with the Heavy Vehicle Simulator on the test sections showed that, amongst other things, waterbound macadam has good resistance to shear failure and forms an excellent drainage layer.

Satellite navigation systems

The National Institute for Telecommunications Research began a project aimed at developing the technical capabil-

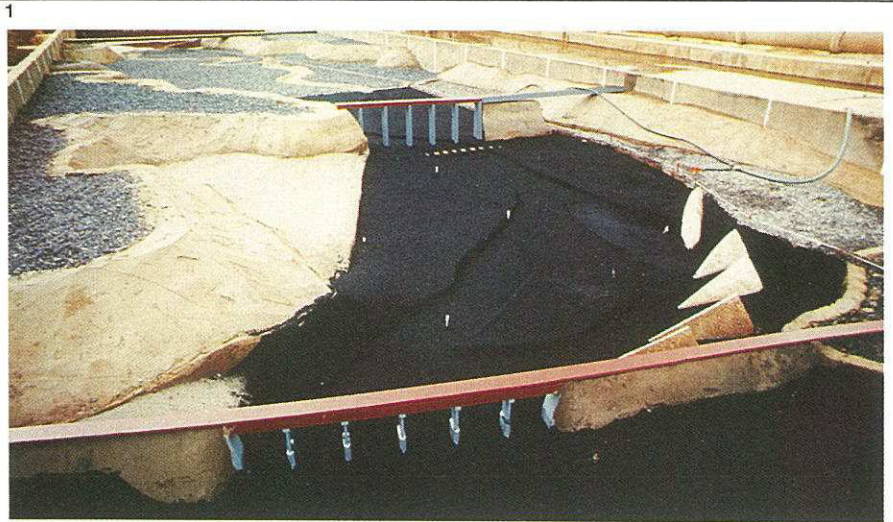
ity and scientific knowledge necessary for the use of a planned satellite navigation system, namely the GPS (Global Positioning System).

With sufficient satellites in orbit around the earth, this system makes world-wide coverage possible at all times. Uncertainty about wave propagation is eliminated by the use of two transmission wavelengths in the microwave band.

The research at the Institute is aimed at a broad area of application, including navigation and position fixing as well as offshore and geodetic surveying. The development of a positioning receiver is under way.

A scale model of the Mzinto River was built by the National Mechanical Engineering Research Institute to find the most effective way of preventing scour damage to the Mzinto railway bridge that can be caused by large floods (page 28).

1. The complete river model. Half of the model was built of gravel and cement, but the actual section studied was constructed of anthracite to allow modification of the riverbed and banks to simulate the real situation.



2



2. Mzinto River model during a 10-year flood. A bull-nosed protection groyne is situated near the bridge to reduce turbulence and to direct the river into a new channel. It protects the bridge from washing away and prevents erosion.

3. Modification of the Mzinto riverbed after a 100-year flood. The test lasted 10 minutes, and simulated 35 hours of real flooding. The river and the lagoon were emptied and the modifications were studied. The north embankment of the river is well protected, a new channel has formed along the groyne and the old riverbed has started to fill.





Weather effects on traffic speeds

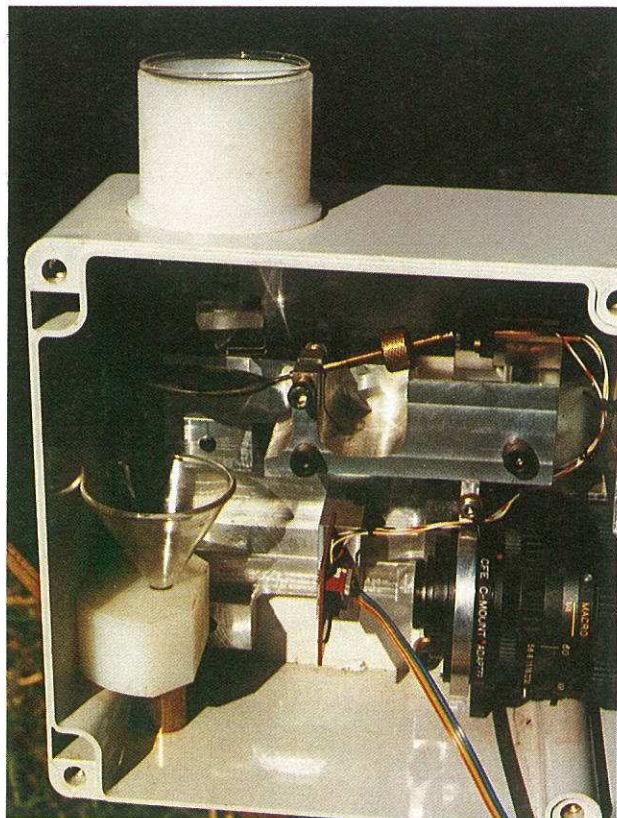
Over the past five years the speed limits on rural roads have been increased in South Africa. There are many roads today for which the speed limit is the same as the minimum design speed. This implies that it is unsafe for drivers to exceed the speed limit at locations where the minimum design speed applies, for example on curves when driving under adverse weather conditions.

To gather information on drivers' behaviour on different classes of road under such conditions, the National Institute for Transport and Road Research developed an automatic device known as WETS (Weather Effects on Traffic Speeds). In conjunction with the TEL (Traffic Engineering Logger) it captures the following variables: real time, vehicle speed and length, vehicle class, lane occupied, start/end time of rain, rain intensity, visibility and wet/dry pavement per lane.

1. The prototype instrument set up at a safe distance from the road, on which traffic loops have been installed. Electrodes on the road surface monitor the wetness/dryness of each lane.

2. A detail of the instrument showing the catchment funnel and the system for monitoring whether or not it is raining and the amount of rain. In this prototype version, visibility is monitored by a separate emitter of modulated infrared light, but a retro-reflective system will be used in the final version.

2



Experimental geological map

The National Physical Research Laboratory compiled geological images of the Barberton area incorporating information on the terrain obtained from satellite data. This product should give geologists better insight into the way in which the topography is determined by the nature of the underlying rock formations.

The images were compiled by means of versatile numerical techniques developed with the assistance of the National Research Institute for Mathematical Sciences. A new experimental geological map of the Geological Survey of the Department of Mineral and Energy Affairs will be based on these images.

Quality control at coal mine

At the request of a coal company, the National Research Institute for Mathematical Sciences carried out a quantitative study of the interaction of various factors that determine the quality of the coal exported from the Richards Bay coal terminal.

The quality of coal depends on the quality of the layers that are mined, the moisture content of the coal and also the relative density of the heavy medium used in the washing plant at the mine.

Formulas were derived according to which the mine can determine a target level for the net calorific value of the washed coal that leaves the plant. A control strategy for the washing plant was also formulated so that the relative density of the heavy medium could be altered in accordance with the net calorific value of the coal.

Magnetic field mapping and modelling

The Magnetic Observatory carries out a programme of regular five-yearly magnetic field surveys which cover South Africa, South West Africa and Botswana. The survey results are used to compile a set of magnetic field maps for Southern Africa which is used for navigational purposes, as reference data for geological exploration work, and as part of the international data set for global magnetic field models. The latest survey campaign was completed early in 1985 and the set of magnetic field maps has been completed for printing and distribution.

The Southern African magnetic survey programme is of great importance internationally for global magnetic field modelling.

Not only is it the only survey programme of its kind on the African continent, but the survey area is also surrounded by a large ocean area in which hardly any magnetic observations are possible.

As these surveys only provide information on the earth's main magnetic field, the Observatory also used geomagnetic data obtained from the MAGSAT satellite to derive a deep crustal total field magnetic anomaly map for South-

ern Africa. This project involved the correction of the satellite data for time-dependent magnetic variations and also the reduction of data from different satellite tracks to a common altitude. A statistical procedure was used to reduce the data to a common altitude, and it proved to be as successful as the inversion methods currently being used for this purpose, but is much simpler to apply on a regional basis. The standard procedure for removing magnetospheric ring current effects from the satellite data also proved to be unsatisfactory over Southern Africa, mainly because of the existence of a large-scale main field magnetic anomaly south of the continent. An improved correction procedure based on more rigorous scientific reasoning was consequently developed to deal with this problem.

The final anomaly map has been made available to geologists to establish how well it fits in with existing knowledge of Southern African crustal tectonics.

Environmental information for oil exploration

The National Research Institute for Oceanology is doing research into wave, wind and current conditions on the Agulhas Bank in the vicinity of the oil-drilling operations of the Southern Oil Exploration Corporation.

This work, which was started in 1978, is aimed at providing detailed environmental parameters required for engineering design purposes as well as a better understanding of the circulation dynamics and stratification of the water on the Agulhas Bank.

Mineshaft research with model

The National Mechanical Engineering Research Institute investigated the impulsive aerodynamic forces that occur when large personnel mine cages speed past each other in mineshafts in which ventilation air is also flowing at high speed.

A dynamic model of a part of the proposed new mineshaft, which functions precisely in the same way as a full-scale prototype, was built. The model mine cages were controlled by a microcomputer and moved at the correct speeds in the model mineshaft. Data on impulsive forces were recorded by miniature pressure converters. It appeared that the impulsive forces that occurred were proportional to the square of the cage speed and the flow velocity of the ventilation air.

The knowledge acquired during the investigation will allow mineshaft designers to design large installations with unusually large personnel hoists and thus contribute towards increased productivity in South African mines.

Utilization of lignin

An investigation into the economical utilization of lignin, a waste product of the pulping industry, was undertaken by the National Timber Research Institute.

It has already been found that lignin produced during the alkali pulping of bagasse can be used with good results in phenol-formaldehyde resins (PF resins). The use of lignin reduces the amounts of phenol and formaldehyde needed for producing resin and therefore makes the process cheaper. Good cold-setting and thermo-hardening lignin PF wood glue types have been produced, and the use of lignin-PF glue in products such as plywood and chipboard is currently being studied. Because PF resins are very costly and a lot is used, the inclusion of lignin in these resins can bring about large savings.

Conversion of bagasse to liquid fuel

In terms of the Renewable Feedstocks Programme, the techniques developed by a number of research groups for converting bagasse (pressed sugarcane) to ethanol and other important materials were evaluated with a view to practical applications.

The Fermentation Technology Division of the National Food Research Institute were very successful in their research on the economical manufacture of cellulase, an enzyme which can convert the hemicellulose of bagasse to fermentable sugars. Good progress is also being made with a process of fermenting xylose, the most important sugar in the cellulose of bagasse, to ethanol.

Fluidized-bed combustion of waste coal and fines

The National Boiler for the Demonstration of Fluidized-bed Combustion, which was built by the National Institute for Coal Research at the request of the National Committee for Energy Research and with financial support from the Department of Mineral and Energy Affairs, was commissioned in 1985.

The main aim of the plant is to demonstrate how fluidized-bed technology can be used for the combustion of waste coal and fines to generate process steam. Large quantities of poor-quality coal, which cost the mining industry huge amounts, are stockpiled as waste in South Africa. Since the Institute began building the boiler, interest by industry in fluidized-bed combustion has greatly increased.

Utilization of pulverized fuel ash

In terms of the National Research Programme for Waste Management and the National Programme for Energy Research, possible uses of pulverized fuel ash (PFA) are being investigated. In South Africa approximately 12 million tons of PFA are produced annually.

A study is being made, amongst other things, of the replacement of part of the cement in concrete and mortar by PFA to improve their durability. This has already been found to be an effective way of preventing the damaging expansion caused by reaction between certain Cape aggregates and portland cements with a high alkali content.

In collaboration with Escom and the Chamber of Mines, an investigation is being made into the possibility of filling old drifts with PFA or using PFA pillars as mine supports so that more coal can be mined without the danger of collapse. PFA can possibly also serve as a source of various minerals, especially alumina and magnesia, which are at present being imported. It is also possible to recover magnetite from PFA.

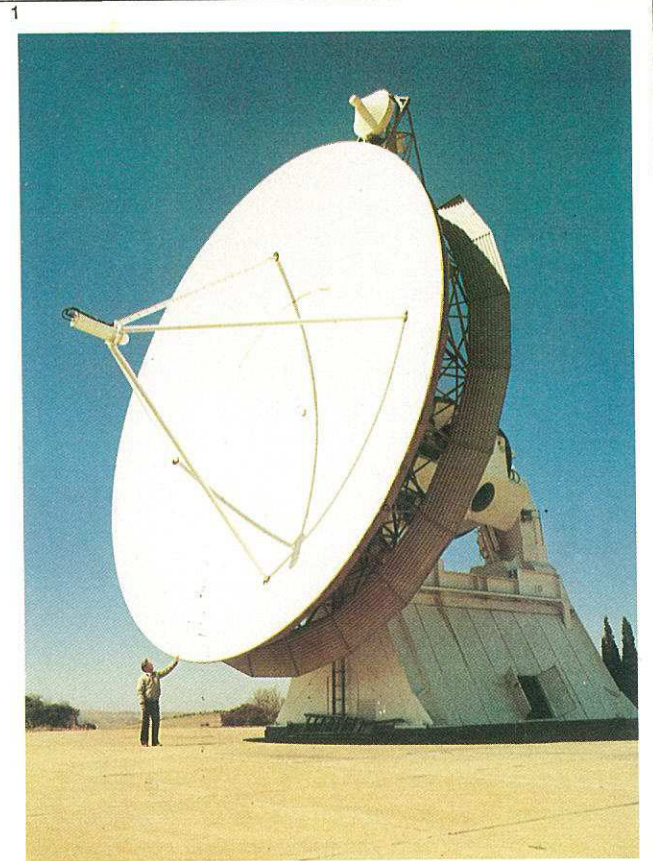
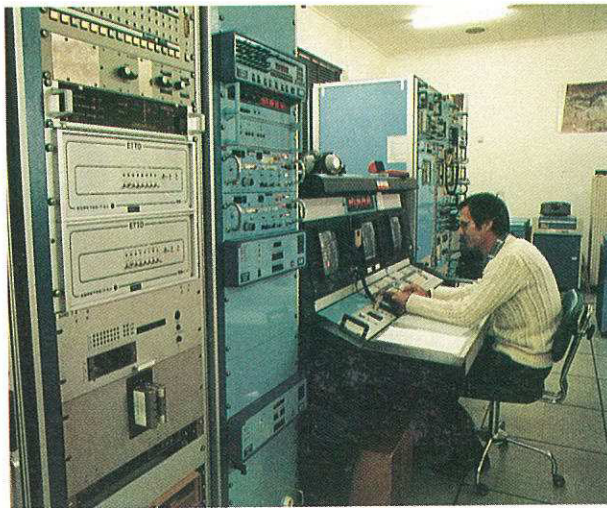
The use of PFA instead of lime as an aid to desulphurization of coal gas at power stations is also being investigated.

The Satellite Remote Sensing Centre of the National Institute for Telecommunications Research is responsible for the acquisition, processing and distribution of satellite data and imagery of the earth's surface and atmosphere.

1. The 12-m parabolic antenna used principally for tracking satellites on behalf of the French Centre National d'Etudes Spatiales.

2. Some of the sophisticated instrumentation in the control room of the Satellite Remote Sensing Centre.

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3. The use of reclaimed asphalt for surfacing and basecourses is being investigated by the National Institute for Transport and Road Research (NITRR). Strips of recycled asphalt mixed in various proportions were laid at the NITRR test site and are shown here undergoing tests for characteristics and performance (page 28).

3



Group for heterocyclic chemistry

A new research group has been established in the National Chemical Research Laboratory to carry out investigations in the field of heterocyclic chemistry. This important branch of chemistry concentrates on ring compounds which contain, apart from carbon, other elements such as nitrogen, oxygen and sulphur.

Chlorophyll, many of the vitamins, DNA, hormones and enzymes all incorporate heterocyclic groups, and most pharmaceuticals and agricultural chemicals also consist of heterocyclic compounds.

The research group prepares new heterocyclic compounds and studies their biological activity. Some of the compounds are sent to a company in Great Britain to test their suitability as pharmaceuticals and insecticides or herbicides.

The research group also develops methods for the preparation of useful South African natural products that do not occur in nature in sufficient quantities.

Membrane recirculation and cell function

The National Chemical Research Laboratory is investigating the parameters which influence the control of membrane specificity in the membrane system of animal cells. By selective marking of various membrane types, it was shown that membrane specificity in the case of simultaneous insertion and removal of intracellular membranes is controlled at the cell surface.

This investigation can throw light on the underlying mechanisms of intracellular membrane communication and should contribute to our understanding of cell function in processes such as cell nutrition, immunological defence, product yield, communication and cell surface control.

Fundamental data on ion exchange chromatography

The National Chemical Research Laboratory has already been providing systematic information for two decades on the so-called distribution coefficients relating to ion exchange equilibria and processes. This knowledge is important because the distribution coefficient gives an indication of the peak leaching volume of an element which is leached out of an ion exchange column and this points out possible separations.

Of the 68 pages of distribution coefficient tables in Wilson & Wilson's book *Ion Exchangers in Analytical Chemistry* (1982), the first 20 consist of data supplied by the Laboratory.

During the year under review, the Laboratory published coefficients for the distribution of 46 elements between the macroporous resin AG MP-50 and aqueous hydrochloric acid as well as hydrochloric acid-methanol mixtures. A comprehensive series of hydrochloric acid and methanol concentrations was used, and at the same time the beha-

viour of the elements was investigated with reference to new and improved possibilities of separation. It was shown that the macroporous resin lends itself to a large number of separations which are not possible with a normal gel type resin. This was the first systematic investigation of this kind to be done with a macroporous resin and hydrochloric acid mixtures.

Structure determination of organic compounds

Concerning new developments in the field of magnet technology and soft ionization techniques, the scope of mass spectrometry at the National Chemical Research Laboratory has been broadened to include biopolymers such as peptides and oligosaccharides. A method has therefore been developed for the determination of the amino acid sequence of cyclic peptides, and the structures of the important natural toxins risonin A and cyanoginosin LA have been determined.

The national facility for mass spectrometry which was established to provide for the needs of organic chemistry laboratories in industry and at universities is also used for research at the CSIR.

Poisoning of catalysts

The National Chemical Research Laboratory investigated the interaction between carbon disulphide and a series of ruthenium hydride complexes with a view to the design of catalysts that are not susceptible to sulphur poisoning. Metals of the platinum group are used on an industrial scale as catalysts, and the catalytic action is often impaired by impurities in the raw materials.

It was found that carbon disulphide was incorporated into the co-ordination sphere of ruthenium as dithioformate, and that dithioformate caused unusual reactivity patterns concerning ligand displacement and isomerization of octahedral ruthenium complexes. Since ligand displacement and isomerization are key stages in various catalytic reactions, the mechanism of these reactions is currently being investigated.

Structure of egg phosvitin

The results of research at the National Chemical Research Laboratory were combined with genetic data from abroad to elucidate the complete chemical structure of a main component of chicken egg phosvitin. This work gives scientists a better understanding of the synthesis, conversion and utilization of such proteins, and also the way in which protein formation is controlled by hormones.

The methods that were developed can also be used for determining the structure of phosvitin-like proteins in bones and teeth and can also help to broaden the knowledge of the chemical aspects of these tissues in healthy and affected states.

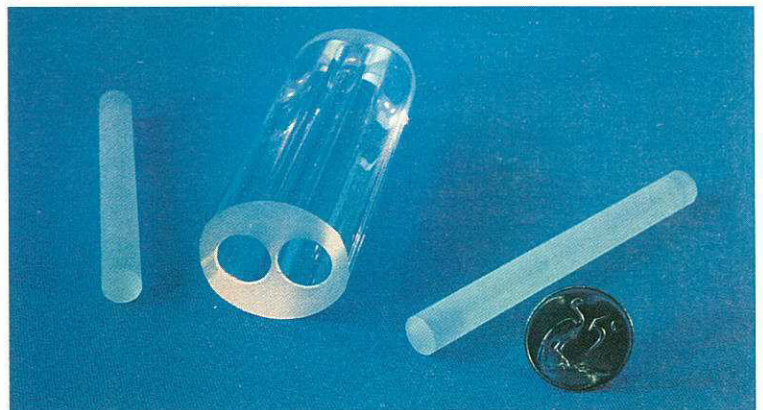


1. Preforming of a lens substrate on a curve generator recently installed at the National Physical Research Laboratory. With a diameter of some 215 mm, this is the largest optical element manufactured to date in South Africa.

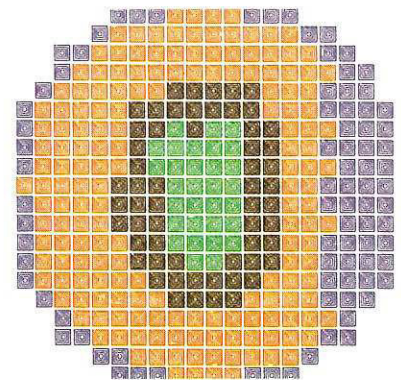
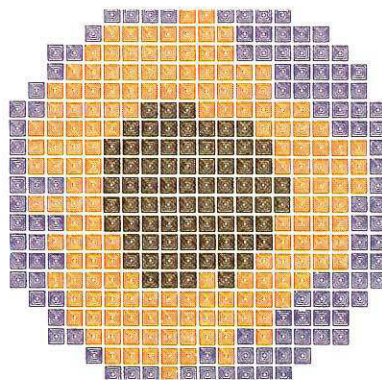
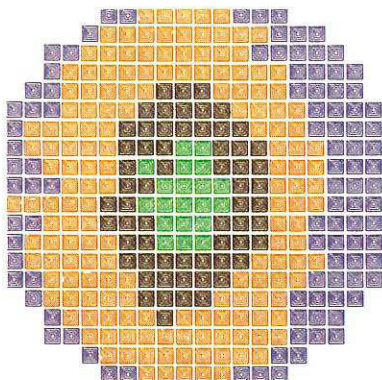
2. Elliptical laser cavity manufactured in the optical materials processing section of the Optical Sciences Division of the National Physical Research Laboratory.

3. Computer simulation of the energy distribution in a flashlamp pumped laser rod when located in an elliptical cavity. The three images represent different cross-sections along the length of the rod.

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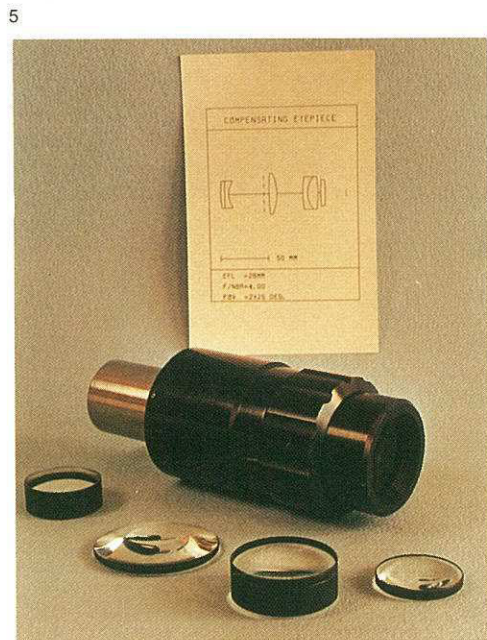
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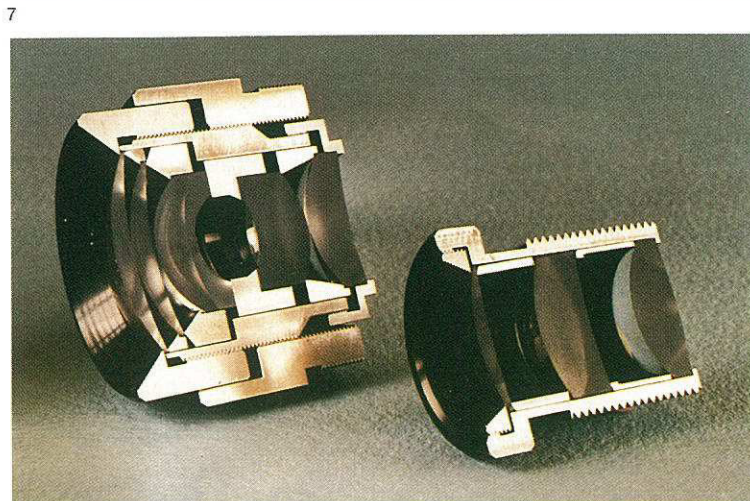
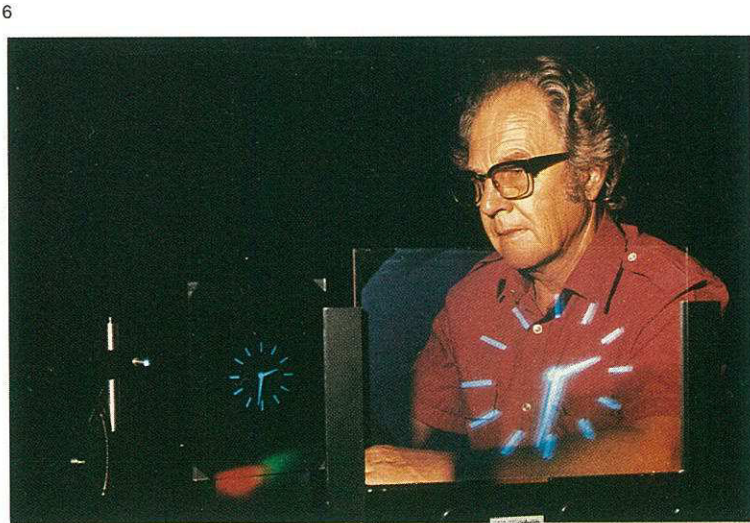
6. The first holographic optical element (HOE) ever produced in South Africa. This simple off-axis lens has a focal length of some 250 mm and an aperture of $f/1.2$. It was produced by the holography section of the Optical Sciences Division of the National Physical Research Laboratory.

7. Four-element 25 mm $f/1.2$ objective lens using the novel zero power corrector concept developed at the National Physical Research Laboratory. A conventional seven-element Double-Gauss lens is shown on the left of the photograph.



4. Special prisms with one cylindrical surface, produced by the Optical Sciences Division of the National Physical Research Laboratory.

5. The 'Pretoria' eyepiece, designed at the National Physical Research Laboratory, corrects the coma of an $f/4$ astronomical paraboloid. A prototype of this eyepiece is currently being circulated amongst amateur astronomers in the USA and has received considerable acclaim.



Dinuclear ruthenium models for heterogeneous catalysts

To obtain more information on the action of heterogeneous catalysts, the National Chemical Research Laboratory started an investigation into the synthesis, structure and reactivity of certain dinuclear ruthenium(II) complexes. Heterogeneous catalysts based on a metal or metal oxide are very important in the chemical industry.

A series of new ruthenium(II) dimers were prepared and unexpected variations in their structure and reactivity were shown by X-ray crystallography. Some dimers also showed unusual catalytic activity in a variety of organic reactions.

Trace elements in rock standards

At the National Chemical Research Laboratory, trace amounts of cobalt were selectively separated from South African rock standards by ion exchange chromatography and then determined by flame atomic absorption spectrometry. Apart from cobalt, accurate analytical values regarding the rock standards have also been determined over the years for zinc, lead, uranium, thorium, copper, gallium and vanadium.

Silicate rock standards are used as a reference in the analysis of rock material of unknown composition - the availability of accurate values for the main and trace element contents of the standards is very important in the field of geochemistry. South Africa has contributed 20 of the 170 internationally accepted rock standards. The South African rock standards are supplied by the Council for Mineral Technology and distributed on request by the South African Bureau of Standards.

Structure determination of chemical compounds

The National Chemical Research Laboratory is currently developing computer programs based on the principles of quantum mechanics and molecular mechanics to determine theoretically the effect of certain molecular parameters on the structure of chemical compounds.

It has already been determined by molecular mechanics, and experimentally confirmed, how the conformation of certain steroids is influenced by substituents. NMR parameters have been elucidated by quantum mechanical calculations through the molecular structure of biologically important compounds such as imidazoles, indoles and benzodiazepines.

Knowledge of the structure of chemical compounds is important, amongst other things, for the development of catalysts, the determination of the properties of polymers and the study of the interaction between drugs and enzymes.

Standard radiation thermometer

The National Physical Research Laboratory developed a standard radiation thermometer which can be used to serve as the national standard for radiation temperature and maintain the International Practical Temperature Scale (IPTS-68) for temperatures above the freezing point of gold, which is an international reference temperature.

The Laboratory decided to build the instrument as the special lamps which are used for the calibration of radiation thermometers are costly and difficult to obtain, and also because the period of validity of calibrations obtained by radiation sources (lamps) is so limited. It appeared that there was a need for alternative secondary standards for which radiation receivers are used, amongst other things, to increase the period of validity of calibrations.

Good results were obtained with the prototype instrument, and it is expected that an efficient standard radiation thermometer will be built in the foreseeable future.

New optical design principle

The National Physical Research Laboratory devised a new optical design concept which makes use of the principle of a zero power corrector to control residual aberrations. The concept can be used to design objective lenses with *f*-numbers down to 0,6 at a focal length of 100 mm using only four optical elements. Such a lens can replace conventional systems containing up to nine elements.

The same concept has been used to simplify the construction of many types of optical system including microscope objectives, eyepieces and magnifiers. A special dual-purpose lens version has also been developed which is unique in that it can be used either as an objective or a magnifier. The construction of such lenses using conventional techniques results in very dissimilar lens forms.

Evaporation of chemical crop sprays

At the request of the Agricultural and Veterinary Chemicals Association of South Africa, the National Physical Research Laboratory developed a method of testing the effectiveness of drop protectors which are added to crop sprays to combat evaporation during aerial crop spraying.

The test consists essentially of determining the evaporation rate of droplets - with and without protectors - under controlled laboratory conditions. This method can be used to evaluate the effect of different drop protectors with the eventual aim of registration by the Department of Agriculture.

Anti-shark cable installed

The National Physical Research Laboratory has been researching practical methods of protecting bathers against shark attacks for some time. A special electric cable was designed which deflects sharks selectively without affect-

ing bathers and harmless fish or destroying the sharks themselves, which would upset the ecology. This method was tested at St Lucia earlier and proved to be extremely effective.

To demonstrate the practicability of the system in a real situation, the cable was installed at Margate's north beach. This is the first time that a system of this type has ever been tried, and the Laboratory had to overcome a host of practical problems. For example, weather and sea conditions had to be just right and known a week in advance so that preparations could be made for installation. Such conditions occur only from May to July. The help of the Weather Bureau in Pretoria was invaluable.

The construction of a power source and installation of supporting equipment is in progress and the Laboratory hopes to be able to report back in the near future on the feasibility and possible general application of the method.

Dating method for the quaternary period

The possible use of thermoluminescence analysis of quartz for dating sand deposits was investigated by the National Physical Research Laboratory. The ages for covered sand layers from the Namib Desert compared well with calibrated ionium dates. Samples from fossil occurrences at Swartkrans have also yielded good relative ages between 100 000 and 1,6 million years, which demonstrates that the technique can be used for most of the Quaternary period.

This new technique seems very promising because it can be applied to various types of sediment, especially the aeolian sands of the Kalahari and the Namib, and because it covers a period for which there is no other reliable dating method.

Effectiveness of hail protection nets

The effectiveness of hail protection nets was investigated by the National Physical Research Laboratory in the laboratory as well as in field experiments.

It was found that sensitive crops could not be completely protected by ordinary nylon nets with a 12,6 mm hexagonal pattern, but that the nets provided adequate protection for motor cars as long as they were in good repair and remained in place.

There is a 50 per cent probability of damage to tomatoes from hailstones 11 mm in diameter and to the bodywork of motor cars from hailstones 30 mm in diameter.

First beam obtained in new particle accelerator

Good progress has been made with the National Accelerator Centre's new accelerator facility at Faure. The last components were installed in the injector cyclotron, which had already been commissioned at the end of 1984, and proton beams were successfully deflected out of the machine. The beam line which connects this cyclotron to the

main accelerator, a separated-sector cyclotron, was fully assembled and instrumented, and on 9 October 1985 beam out of the injector was accelerated for the first time up to full radius in the separated-sector cyclotron. Beam lines to the various user areas have also already been partially assembled.

Usable beams of accelerated charged particles are now expected to be available to users from all parts of the country and abroad by the middle of 1986 for basic and applied research. In view of this, all potential users of the new facility were invited in November 1985 to submit research proposals for the period July to December 1986 to the National Accelerator Centre for consideration for the allocation of beam time.

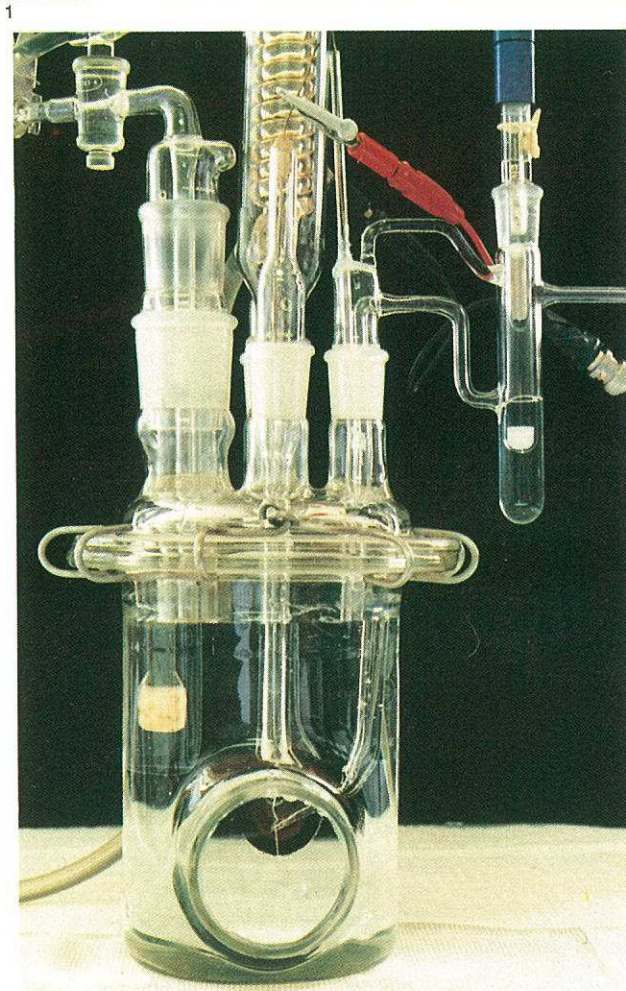
Astronomical observations

Recently several groups of astronomers have claimed that the object R136 at the centre of the Tarantula nebula in the Large Magellanic Cloud is 3000 times more massive than the sun, over twenty times more massive than any other known star. Stars of such high mass are not expected theoretically and because of the importance of this result the object has been studied in detail using the CCD (charge-coupled device) digital detector on the 1,0-m telescope at the South African Astronomical Observatory (SAAO). Maximum entropy deconvolution of the images obtained resolved a number of previously unseen components and allowed an upper limit of 200 to 300 solar masses to be placed on R136. The results disprove the claim that this object is supermassive.

Globular star clusters are amongst the oldest known objects and their ages provide a lower limit to the age of the Universe. CCD detectors have revolutionized work on these objects - a team of astronomers from the Royal Greenwich Observatory and the Rutherford-Appleton Laboratory (UK) used the SAAO 1,0-m CCD system to make precise observations of one such cluster. These results were combined with complementary work on the Anglo-Australian 4,0-m telescope to give an age of 16×10^9 years. The Universe must be at least as old as this.

Galaxies provide the means with which to study the large-scale structure of the Universe. The SAAO is at present engaged in two important projects to determine the velocities and brightnesses of galaxies. One project is being done in collaboration with the California Institute of Technology (USA) and the other with the University of Durham (UK). These projects are expected to add significantly to our understanding of the distribution and motions of galaxies in space.

Extensive observations by SAAO astronomers have shown that the Small Magellanic Cloud, one of the two nearest galaxies to us, has a great depth in the line of sight. The curious long, twisted structure that the obser-



1. An electrochemical cell used by the Corrosion Research Group of the Analytical Chemistry Division of the National Chemical Research Laboratory.

2. Damage done by corrosion to a brass pipe in a heat exchanger, investigated by the Corrosion Research Group of the National Chemical Research Laboratory.

Facing page: **Manipulation of digital terrain models**

The Computer Science Division of the National Research Institute for Mathematical Sciences is investigating the uses of digital terrain models. An imaginary grid is placed over the area of interest and one or more parameters are measured for every grid element so as to obtain a three-dimensional model of the terrain. The data were obtained from the Chief Director, Surveys and Mapping, in Mowbray. At present a prototype system is being used to investigate the basic aspects in the handling of the model. A more comprehensive system is being developed.

1. Top view of a terrain model of Cape Town showing the elevation above sea level. Each grid block represents an area of 40 x 40 m. Outstanding geographical features were digitized by vector methods and superimposed on the model.

2. A hill-shade model of the terrain for 08h00 on 1 April 1986. The angle of incidence of the sun on the terrain is calculated so that it can be determined which areas are in sunlight and which in shadow. Green indicates light and red indicates shadow.

3. Perspective horizontal view of the terrain as seen from the area around Blouberg Strand.

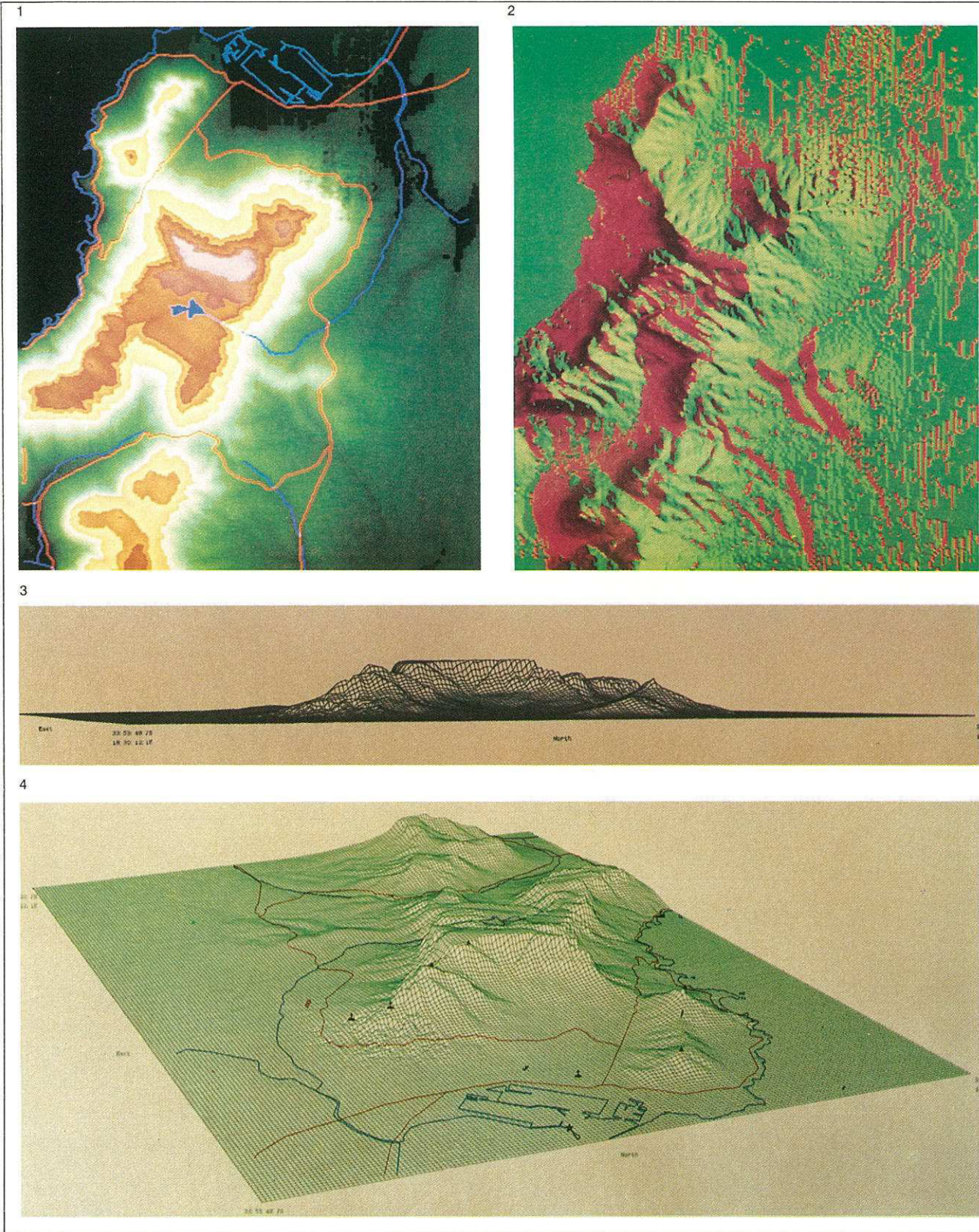
4. Perspective aerial view of the terrain with line and point symbols indicating outstanding features.

2



Review

Directed research



ations reveal suggest that this galaxy has been distorted by strong tidal effects which probably occurred during a close passage of the Small and Large Magellanic Clouds some 200 million years ago.

Research on magnetic pulsations

Research on geomagnetic pulsations in the ultra-low frequency (ULF) range at the Magnetic Observatory focusses on certain aspects of Pc3 pulsations at low latitudes.

The study of Pc3 pulsations recorded along the L=1.76 shell extending from Gough Island in the South Atlantic to Graaff-Reinet was continued. In particular, the unexpected absence of Pc3 pulsation activity during local morning hours at Gough Island was investigated. This occurrence is ascribed to the combination of two factors: firstly, the toroidal resonance frequency of geomagnetic field lines at Gough is higher than for similar field lines in South Africa, and secondly, the source frequency is limited in bandwidth. As a result, the resonance frequency at Gough lay outside the source bandwidth during local morning hours, whereas the resonance frequency at stations in South Africa fell within the source bandwidth.

The relationships between geomagnetic Pc3 pulsations and oscillations of ionospheric Doppler velocity were investigated. Research led to three models being proposed to account for the observed relationships, but the relative contributions of each of the models is not yet clear. Once this has been clarified, it should be possible to make an accurate determination of the ionospheric electric field associated with geomagnetic pulsations at low latitudes.

Improved safety for cooling towers

The National Building Research Institute is investigating the failure mechanisms of large cooling towers under wind loading with the aid of a computer program which it has developed. South Africa is building some of the world's largest reinforced concrete cooling towers at its new power stations. Those at the Kendal Power Station are 165 m high and have a base diameter of 145 m. They cost approximately R4 million each. The design of these ultra-large structures presents special problems to engineers in the light of concern about current design practices, following the collapse of a number of cooling towers in Europe during wind storms.

By using its special computer program the Institute is able to simulate the pattern of behaviour of large cooling towers under increasing wind forces and to define certain deficiencies in the design codes now in use. The Institute is in close contact with Escom, to which the findings will be made available.

Identification of key blocks in excavations

At the request of the Geomechanics Division of the National Mechanical Engineering Research Institute, the Na-

tional Research Institute for Mathematical Sciences developed a computational method which compiles a complete list of the various block shapes which can occur in an excavation in jointed rock, using only measurements on borehole core samples as input data.

Joints in rock masses usually occur in families of more or less parallel joint planes which divide the mass into blocks and layers. If a tunnel or cavern is excavated out of the rock mass, some of the blocks can loosen and collapse. As soon as the first blocks collapse, others that were held in position by them can also loosen and collapse.

Key blocks are the critical blocks which must first fall before other blocks can loosen. It is important for them to be identified so that they can be supported with bolts to prevent rock falls.

The new method has been applied, under contract to a consulting engineering geologist, during feasibility studies for the proposed Lomati water tunnel.

Bounds for orthonormal polynomials

Improved mathematical bounds for systems of orthonormal polynomials have been established at the National Research Institute for Mathematical Sciences. Such bounds are used to establish the convergence of interpolation, orthonormal series and quadrature methods. These methods are widely applied, for example in the approximation of complicated functions by simpler ones, as in the computation of the areas of complicated surfaces, and the computerized solution of differential equations.

Finite temperature calculations

A systematic investigation of the thermal response of nuclear systems was carried out by the National Research Institute for Mathematical Sciences.

Techniques were developed which for the first time permit the calculation of the temperature effects of nuclear reactions, which are generally disregarded in nuclear structure calculations. A specific application was the calculation of the thermal excitation of the low-lying states in the magnesium nucleus.

Curved finite elements and curve approximation

Some problems concerning the use of curved finite elements have been resolved at the National Research Institute for Mathematical Sciences. An iteration method for the calculation of certain special integrals and also a simple and effective algorithm for curve approximation by parabolic curve segments were developed.

This work finds application in extending the widely used finite element method which is applied especially to the analysis of mechanical stresses in components and structures such as airframes and bridges.



An argon laser at the National Physical Research Laboratory — the laser has become an indispensable tool in certain fields of scientific research.

Computer synthesis of speech

The National Electrical Engineering Research Institute is investigating mathematical methods of encoding human speech so that it can be stored and reproduced by computer. Using standard micro-processors, researchers have already succeeded in substantially decreasing the number of bytes required for acceptable speech quality in comparison with conventional digital speech synthesis systems.

The research is aimed mainly at the development of a system which can deal with real-time speech compression. Amongst the applications of speech compression are voice warning of danger or process deviation in industry, electronic message handling and speech security.

Microprobe analysis for the determination of light elements

With a view to future requirements, the National Institute for Materials Research has begun to use the electron microprobe X-ray analyser, which was installed at the Institute in 1982, for the determination of the light elements boron, carbon, nitrogen and oxygen. These elements are present in many of the materials investigated by the Institute.

Preliminary results of the determination of carbon in carbide phases in white cast iron showed that the analysis is sufficiently accurate for the phases present in the material to be identified.

Electron microscopic determination of foil thickness

A theoretical study of the complicating effects caused by the layer structure of molybdenum disulphide was carried out by the National Institute for Materials Research. Molyb-

denum disulphide is an important material in the technology of energy storage.

The foil thickness of samples is important for the interpretation of data obtained from the analytical electron microscope. It is generally known that electron diffraction with a convergent beam is the most accurate way of determining the sample thickness of metal foil. The results of the investigation confirmed that accurate determination of sample thickness is possible with molybdenum disulphide.

Surfaces of semiconductors

In its investigation of a number of metal-semiconductor and semiconductor-semiconductor thin-film systems, the National Institute for Materials Research used Auger electron spectrometry to study processes that remove oxide layers from semiconductor surfaces. A cleaning process was developed which ensures optimum cleanliness before thin films are deposited on semiconductor surfaces. Results obtained by this technique were also used to derive a set of parameters for the preparation of conducting contacts.

Depth profiling was done by ion atomization and Auger analysis techniques to obtain information on the reactions between semiconductors and various metals. Secondary ion mass-spectrometry showed that indium, which is often evaporated as a conducting contact onto mercury cadmium telluride, diffuses into this semiconductor even at room temperature and therefore affects the electrical measurements of the material.

Carbide-forming elements and the hardenability of low-alloy steel

In an investigation concerned with the development of molybdenum-free, medium-carbon low-alloy steel, the National Institute for Materials Research studied the effects of the addition of the carbide-forming elements vanadium, zirconium, titanium and niobium. It was found that the effect of these elements on hardenability is critically dependent on the steel-killing additives silicon, aluminium and titanium which are used to remove oxygen and nitrogen from the melt.

The results showed a considerable improvement in the hardenability of vanadium in steel killed with aluminium and titanium, as well as that of zirconium in steel killed with silicon. The results have led to a re-evaluation of the possible collective effect of boron and vanadium in low-alloy steel.

Lithium batteries

The National Institute for Materials Research studied a number of selected metal oxides and sulphides with a view to using them as solid-solution electrodes in miniature lithium batteries.

In particular, it was found that certain spinel compounds with the general formula $A[B_2]X_4$ can accommodate considerable quantities of lithium within their structures. An important observation was that the $[B_2]X_4$ framework of the spinel structure remains unchanged during the lithiation process; this $[B_2]X_4$ spinel framework has an interstitial space that permits three-dimensional diffusion of lithium through the structure.

The $Li[Mn_2]O_4$ spinel is therefore of particular importance as lithium ions can not only be inserted into, but also removed from, the interstitial space of the $[Mn_2]O_4$ spinel framework, which increases the capacity of the spinel working electrode.

These findings are of significance for the development of lithium-manganese oxide cells for lithium batteries.

Study of two-phase systems

The first stage of a joint project of the National Institute for Materials Research and the NCRD in Israel to determine the effect of high pressure on two-phase systems has been completed.

Research was done on important materials such as tool steel, tungsten carbide and alumina ceramic materials which are used by the mining and engineering industries.

The results showed that combinations of pressure and heat treatment greatly improved the mechanical properties of the material. Basic research was also done on the mechanisms of two-phase systems with alkali halide model systems.

Cumulative deformation and wear

Recent research at the National Institute for Materials Research revealed a purely mechanical mechanism of the wear of hard non-metallic crystals when traversed by considerably softer lubricated metal surfaces. This represents an important element in the mechanisms of wear for such solids which has not been reported or considered previously. The implications for the fundamental understanding of wear in all crystalline solids are that further investigations will lead to an enhanced appreciation of the way in which properties can be maximized.

The way in which hard materials degrade by surface wear in practice is of particular importance in the South African context owing to the large industrial investment in the manufacture of tool materials.

Gizzard erosion in chickens

The Fishing Industry Research Institute was involved in an extensive investigation into the phenomenon of gizzard erosion in chickens, which has become a problem in South Africa since the introduction of South American fish meals into the diets of chickens.

An amino acid known as gizzerosine has been successfully isolated in Japan and identified as one of the causative agents in gizzard erosion. Efforts in South Africa are currently being directed towards synthetic production of gizzerosine in sufficient quantities to permit further gizzard erosion tests in chickens.

Good progress has been made at the Institute in developing a method for the determination of gizzerosine in fish meal. This procedure, which is fairly lengthy, involves the use of ion exchange and high performance liquid chromatography. Future work will be directed towards refining and standardizing this technique with the aim of using it as a routine screening method for fish meals.

Air pollution in Soweto

Sampling to determine the concentrations of sulphur dioxide, nitrogen oxides, suspended particles, anions and trace elements in the air was carried out at two points in Soweto by the National Physical Research Laboratory, Escom and the University of the Witwatersrand.

Measurements at one of the points in 1983 showed that high dust concentrations in the air occurred even on the outskirts of Soweto. The concentration of sulphur dioxide was up to five times higher than it was out in the country.

More complete data will have to be collected before valid conclusions can be drawn. The results should ultimately show to what extent the air quality will improve after electrification, and can also be of value for an investigation into the relationship between air pollution and respiratory ailments.

Airflow patterns in the Southern Cape

The latest study on air pollution and related meteorological phenomena conducted by the National Physical Research Laboratory for the Department of Constitutional Development and Planning covers the area of Mossel Bay and George.

The analysis of the data obtained by surface anemometers has shed new light on surface air flow patterns, their daily course and seasonal variations. Supplementary wind and temperature measurements were made up to an altitude of 300 m with anchored balloons.

Recommendations based on the results of the investigation were made on the siting of industries in relation to residential areas, as well as on the height of industrial factory stacks.

Survey of Cape coast

A survey of the Cape coastline is being undertaken by the National Research Institute for Oceanology in co-operation with the Cape Provincial Administration and the Department of the Environment. This survey is aimed at identifying the sensitive natural components of the coast - dunes, eroding shorelines and important plant communities - so that cognizance can be taken of these in the planning of developments along sections of the coast, particularly for recreational purposes.

A successful pilot study was carried out along the Cape west coast between the Berg River and Bokbaai. This was followed by a second study covering the coast between Bokbaai and Macassar Beach (False Bay), a region under intense pressure owing to the recreational needs of residents of the greater Cape Town metropolitan area.

A third survey, which will encompass the coast from the Gouritz Estuary to the Great Fish River, is planned for 1986. Information on the Mossel Bay coastal region is ur-

gently required by planners of the Cape Provincial Administration as this area will be the centre of the petrochemical industry based on the off-shore gas discoveries.

Prediction of wind-driven sand movement

The National Research Institute for Oceanology has devised a method for predicting wind-driven sand transport rates in dunes, based on various existing formulas.

The rate of wind-driven sand movement in a given dune-field is an important parameter needed to determine management strategies for sand dune-fields. Although until recently little attention has been paid in engineering circles to the possible effects of wind-blown sand transport, there is a wealth of literature on the subject going as far back as 1936.

The method devised by the Institute makes it possible to predict wind-driven sand transport rates on the basis of 16 existing formulas revealed by an extensive literature study. This method has been applied to a number of sites along the Southern African coast, notably the dune-fields around Port Elizabeth and those in the vicinity of Walvis Bay. Measurements of dune advance rates at both these sites have been used to verify the technique.

Metal-binding proteins as pollution indicators

The National Research Institute for Oceanology has found that metal-binding proteins can be useful indicators of environmental pollution by trace metals. The presence of these proteins in plants and animals provide a physiological indication of stress resulting from trace metal pollution in their environment.

The use of these indicators has been developed to the stage where they can be used for a monitoring study of marine animals in the Granger Bay area and other parts of Table Bay. Once the new Green Point sewage outfall is operational, metal-binding proteins will be used to determine whether changes in stress occur in mussels in these areas over a period of time.

Sensitivity atlas of the coast

A sensitivity atlas of the South African coast was published in the year under review. It resulted from the research programme for oil pollution which was carried out under the auspices of the South African National Committee for Oceanographic Research with financial support from the Department of Transport.

The mapping material of the South African Topographical Series (1:250 000) was supplied by the Directorate of Surveys and Mapping. The necessary information for the geomorphological classification and sensitivity index was obtained from the Sea Fisheries Research Institute, and the final cartographic work was done by the Institute for Cartographical Research at the University of Stellenbosch.



It is hoped that the atlas will help the Departments of Transport and Environment Affairs to deal quickly and effectively with oil spills on our coast.

Investigation of stack plumes

A variety of complex flow dynamics problems concerning the behaviour of emission plumes from cooling towers and industrial stacks can now be solved cheaply and efficiently in South Africa owing to unique water tunnel techniques developed by the National Mechanical Engineering Research Institute. Air pollution, the efficiency of power sta-

1. Erosion damage to a seawall resulting from the placing of fixed structures (a sleeper palisade backed by a tarred walkway) on an unstable part of a beach. New beach protection works have now been constructed in a more stable area higher up on this beach. The coastal sensitivity survey undertaken by the National Research Institute for Oceanology (referred to elsewhere in this report) is aimed at providing information which will prevent such costly errors.

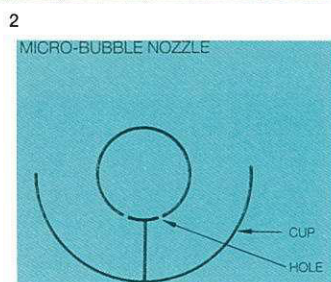
2. Water tunnel simulation of plumes from the dry air cooling towers of a power station. This technique was developed by the National Mechanical Engineering Research Institute.



Flotation for the removal of algae from surface water

Excessive growth of algae and other aquatic plants in dams serving as drinking water sources is caused by the discharge of nutrient-rich sewage effluent over several years. Release of oxygen by algae during photosynthesis leads to the formation of a low-density floc which does not settle readily and therefore cannot be removed by conventional water purification sedimentation processes.

1. Hartbeespoort Dam has been described as the most eutrophic (nutrient-rich) dam in the world. Water from the dam is purified and supplied to various consumers.



2. & 3. The National Institute for Water Research (NIWR) has carried out applied research into the dissolved air flotation process during which minute air bubbles are formed and attach to the algae. The density of the bubble-algae conglomerates is less than that of the water and they rise to the surface and can be skimmed off. This process is currently being applied for drinking water purification at Schoemansville, Richards Bay and Temba and by several industries. A micro-bubble aeration nozzle for use in this process was developed by the NIWR in 1982.

4. Air-saturated, pressurized water forced through the nozzle forms myriads of microscopic air bubbles.

5. The flotation tank at the Schoemansville water purification plant designed in consultation with the NIWR, showing the float (flotated algae).

tion cooling towers and chemical erosion of structures are some of the problems that have to be dealt with. In the past, South African industry often had to have this type of research done overseas by organizations with experience in wind tunnel testing techniques.

The use of alcohol is an important technique to simulate the lower density of stack plumes in the testing chamber of a water tunnel. Winds are also simulated in the water tunnel so that the effect of wind on the dispersion and general behaviour of plumes can be studied.

For example, by using water instead of air as the flow medium, it can be accurately determined to what extent the cooling efficiency of a dry air cooling tower is impaired by recirculation between adjacent cooling towers.

Management system for urban and regional planning

The National Building Research Institute is developing an integrated management system to simulate the interaction of the factors that contribute towards the stimulation or retardation of growth in the various sectors of a city or region.

Alternative development plans based on assumptions with regard to growth patterns of factors such as job opportunities, housing and infrastructure can be compared and evaluated using a computerized simulation model. This adaptable system has already been put to the test in the planning of a new municipality and will shortly be used in other cases of medium and long-term planning.

Eutrophication of Hartbeespoort Dam

The National Institute for Water Research has completed the first phase of an intensive study of Hartbeespoort Dam which was begun some years ago. The excessive enrichment (eutrophication) of the water by plant nutrients such as nitrogen and phosphate, especially from the dumping of purified sewage water and industrial effluent into feeder streams, has in the course of time caused an imbalance in the physical, chemical and biological constituents of the dam. From the results of an in-depth study of the structure of this hypereutrophic water system and the interaction of its components, it seems that the legal phosphate concentration limit of 1 mg/ℓ will not make much difference to the degree of enrichment. The most promising solution appears to be to build a smallish dam above the Hartbeespoort Dam to lower the phosphate concentration in the main dam and to aerate the water.

In the second phase of the investigation more scientific results on the functioning of the water systems will be obtained, and the effects of the 1 mg/ℓ limit on the orthophosphate concentration will be monitored.

Various articles on the project have appeared in international scientific journals and papers on the subject have

been read at conferences. The complete results of the investigation are contained in a report.

Satellite observation of the Agulhas Current

The Satellite Remote Sensing Centre of the National Institute for Telecommunications Research built an electronic image processing interface with the aid of which oceanographic data from an American satellite can be recorded and converted to infrared ocean images with good resolution.

The data, which amongst other things give a good indication of the sea temperature, are recorded daily over the Agulhas Current and supplied to the Woods Hole Oceanographic Institution in the USA. Images are also regularly made available to the National Research Institute for Oceanology.

Threatened South African birds

A book on threatened birds in South Africa, which appeared during the year under review, is based on research done under the auspices of the Nature Conservation Research Division of the National Programme for Ecosystems Research.

The book, which is entitled *South African Red Data Book - Birds*, gives facts and figures on more than a hundred bird species, the nature and degree of the threat to which they are exposed, and possible conservation measures. It also contains distribution maps and lists of published sources.

Kuiseb environmental project

The development of the world's largest open-cast uranium mine in the Namib Desert caused rapidly increasing demands for water in the area in the early 1970s. In the absence of scientifically based information on the likely impact of water extraction from the fragile desert ecosystem, a co-operative research project was initiated by the Ecosystems Section of the Foundation for Research Development in collaboration with various government departments and universities to investigate the situation.

A synthesis report, *The Kuiseb environment: the development of a monitoring baseline*, has now been published. The report outlines the nature of the regional environment and the types of change expected to occur in the area as a consequence of water extraction from the Kuiseb River. It also provides details of features of the geomorphology, hydrology and ecology that might be used as baselines against which to measure changes within the system.

New national accelerator facility officially opened

The National Accelerator Centre's new accelerator facility at Faure was officially opened on 18 October 1985 by the State President, Mr P W Botha. The ceremony was attended by several other dignitaries, a large number of invited guests, potential users of the facility and NAC staff members.

It is expected that the facility will be available for research, radiotherapy and the production of radioisotopes using beams of accelerated charged particles from about the middle of 1986.

Experimental nuclear physics at intermediate energies

A symposium on experimental nuclear physics at intermediate energies was presented by the National Accelerator Centre (NAC) on 17 and 18 October 1985 at the University of Cape Town, to coincide with the official opening of the NAC's separated-sector cyclotron facility at Faure on 18 October 1985. The symposium was attended by 55 delegates, and papers were presented by a number of distinguished nuclear physicists from abroad as well as by some local experts. In this way interest in the type of basic research which can be done at the NAC's new accelerator facility could be stimulated amongst potential users.

Workshop on marine biological data

In August 1985 the South African Data Centre for Oceanography (SADCO) held a workshop to introduce marine biologists to the facilities and services offered by the Data Centre. The workshop was held at the National Research Institute for Oceanology where the Data Centre is based.

This was the first meeting of its kind to be organized by SADCO since its establishment in 1977. It was a great success and similar workshops are being contemplated for the future.

Computer-integrated manufacturing

As a result of a recommendation by the Co-ordinating Committee for Research on Computer-Integrated Manufacturing, a member of the National Electrical Engineering Research Institute and a lecturer at the University of the Witwatersrand were appointed to investigate the research requirements in the field of computer-integrated manufacturing so that recommendations on a national research strategy can be made.

Various research and industrial organizations have already been visited and international conferences on computer-integrated manufacturing have been attended. Provisional recommendations have been discussed by the Co-ordinating Committee and a final report will be submitted to the President of the CSIR.

Analytical chemistry

The second international symposium on the application of analytical chemistry in the exploration, mining and processing of minerals was held in April at the CSIR Conference Centre under the auspices of the International Union for Pure and Applied Chemistry.

The Symposium Secretariat of the CSIR was responsible for the arrangements. Approximately 350 scientists from 23 countries attended the symposium.

Forestry products

A symposium entitled *Forest Products Research International - Achievements and the Future* was held in April at the CSIR Conference Centre.

The symposium was arranged by the National Timber Research Institute in collaboration with the Directorate of Forestry of the Department of Environment Affairs, the Faculty of Forestry of the University of Stellenbosch and the South African forest products industry. It was attended by 515 delegates from 27 countries. Two hundred and sixteen papers were read at 16 seminars, each dealing with a particular aspect of the Institute's work.

Appropriate sanitation technology

Members of the National Building Research Institute and the National Institute for Water Research helped to give a series of seminars in March at various centres on appropriate technology for sanitation.

Approximately 200 participants were given information on the provision of drinking water and sanitation facilities to low-income communities.

Water supply

The second seminar on water supply and sanitation in developing areas was held in February in Ciskei. The first seminar on this subject was held in Venda in 1983.

These seminars are part of the contribution of South Africa towards the International Drinking Water Supply and Sanitation Decade and are arranged by the South African National Committee of the International Water Supply Association in collaboration with the National Institute for Water Research and the responsible government departments.

Stereochemistry

The tenth binational symposium resulting from an agreement between the CSIR and the National Council for Research and Development in Israel was held in March at the CSIR Conference Centre.

Stereochemistry was the subject of the symposium, which was attended by approximately 80 local delegates and nine Israeli scientists.

1

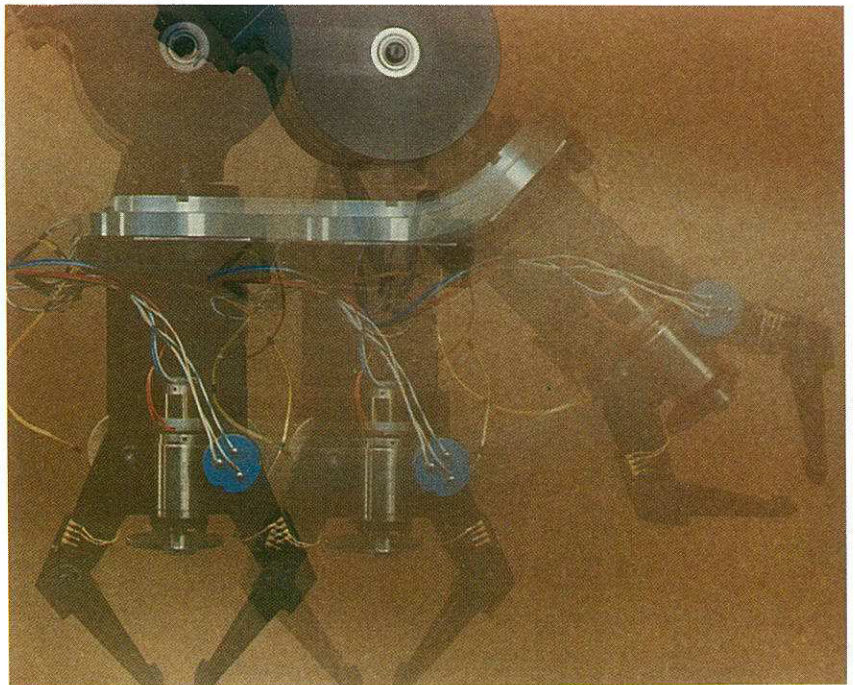


2

The National Electrical Engineering Research Institute developed a unique robot gripper. It has two degrees of freedom and is equipped with force, position and velocity sensors. A special micro-computer processes the sensory information and makes logical decisions concerning the operation of the gripper. What makes it unique is that it can respond to sensory feedback from its environment without having to be programmed each time. Because of its ability to 'feel', it is highly suitable for handling delicate electronic components.

1. The gripper attached to a commercial robot arm.

2. A multiple exposure captures the gripper in action.



National light standard for New Zealand

The equipment purchased by the Physics and Engineering Laboratory of New Zealand for the establishment of a national measuring standard for light and radiation measurement is based on a design by the National Physical Research Laboratory (NPRL). The Laboratory in New Zealand granted the scientist from the NPRL who developed the equipment a research bursary to install it. The researcher was able to replace costly commercial instruments in the measuring system by much cheaper components which he developed himself. At the same time he improved the sensitivity of the system.

The experience gained will be used for improving the NPRL's own measuring facilities.

Hologram of the Taung skull

An American expert in holography, Dr Kenneth Haines, who was commissioned by the *National Geographic* magazine to make a reflection hologram of the Taung skull, worked in close collaboration with the National Physics Research Laboratory. He was assisted by staff of the Optical Sciences Division, and the Laboratory's facilities were used to make the master transmission hologram. The hologram appeared on the front cover of the magazine's November 1985 issue whose feature article is the origin of man.

Holography is a specialized technique in which laser light is used to fix an image of a three-dimensional object on a photographic plate. The hologram is actually a combination of interference patterns which are meaningless unless viewed under certain conditions: when the plate is illuminated by a laser beam, an extremely life-like three-dimensional image of the original object is re-created.

The Taung skull, which was discovered 61 years ago in the Northern Cape, is that of a female child who lived between one and three million years ago, according to experts. The skull is kept at the University of the Witwatersrand.

Evaluation of satellite images

A proposal submitted by the National Physical Research Laboratory to a French company on the evaluation of images received from the satellite SPOT 1 has been selected from more than 300 competing proposals from 48 countries. Only 132 proposals were finally accepted.

The Laboratory intends to determine to what extent the French satellite with its high resolution (20 metres in full colour and 10 metres in black and white) is capable of detecting small-scale surface phenomena of concern to earth scientists involved in Antarctic research. The data will be evaluated in collaboration with the South African National Committee for Antarctic Research.

International Antarctic activities

The eighteenth meeting of the international Scientific Committee for Antarctic Research (SCAR), one of whose vice-presidents is Mr J P de Wit, a Deputy President of the CSIR, was held during the year under review in Bremerhaven, West Germany. The South African delegation consisted of Mr De Wit, Professor W R Siegfried (University of Cape Town), Professor J A Gledhill (Rhodes University), Dr P R Condy (CSIR) and Mr J G Nel (Department of Transport).

Aid with housing on the Comores

During a visit by a delegation from the Federal Islamic Republic of the Comores to South Africa in 1983, the Department of Foreign Affairs arranged discussions between the delegates and housing experts at the National Building Research Institute.

The discussions resulted in a visit by researchers from the Institute to the Comores. It was agreed that the Institute would help the country with the design and co-ordination of two construction programmes and give continued technical aid with certain housing problems. Good progress has already been made with the drafting of planning and design requirements and the experimental work on the development of appropriate construction techniques.

Co-operation with Natal-KwaZulu Planning Board

The National Building Research Institute was invited to participate in some of the activities of the Natal-KwaZulu Planning Board, namely in the fields of housing, urban and area planning, and water and sewerage.

The Planning Board was created in 1984 to investigate how the standard of living of Blacks in KwaZulu, especially in the Greater Durban area, could be improved.

Air pollution

The Secretariat of the National Programme for Research on Weather, Climate and Atmosphere at the Foundation for Research Development had an important share in the arrangements for the Sixth International Conference on Air Pollution held in October 1984 at the CSIR Conference Centre. The aim of the Conference, which was attended by some 360 delegates from 15 countries, was to gain perspective on problems and developments in the field of air pollution in a First and Third World community.

Particle technology

A course on particle characterization was given by the Chemical Engineering Research Group in collaboration with the South African Institution of Chemical Engineers to introduce new developments in this field to South African industry and laboratories. The developments are mainly due to progress in laser technology and electronic data processing.

Raw materials, intermediate products, end products and waste material often consist of particles or are, in the case of liquids and gases, contaminated by particles. The processes which are used to form, process or remove particles require thorough knowledge of particle characteristics, in other words the determination of the size and shape, the porosity, pore size distribution and the surface area of particles.

Research on catalysis

The Chemical Engineering Research Group arranged a colloquium on catalysis research held at the Alpha Training Centre at Broederstroom. The Group is investigating methods of economically converting synthesis gas from carbon into motor fuels and petrochemicals, which is why it is important for other researchers in the field to be kept informed of developments.

Some of the subjects discussed at the colloquium were Fischer-Tropsch synthesis of hydrocarbons, the production of liquid hydrocarbons by alkene/alkylene oligomerization and the preparation of catalysts.

Development of software technology

A seminar on the development of software technology was presented on 4 and 5 February 1985 by the National Research Institute for Mathematical Sciences in conjunction with Software Management Systems (Pty) Ltd.

The purpose of the seminar was to explain and illustrate a scientific approach to the defining, controlling, coding and testing of large software systems. It was the sixth in a series of summer seminars and was attended by 69 practitioners and managers of large software projects, more than half of whom were from the private sector.

Lightning research: assistance to Brazil

As was reported last year, the National Electrical Engineering Research Institute was awarded a contract for the supply and installation of equipment for a lightning parameter research project being undertaken by an electricity supply company in the Brazilian state of Minas Gerais. The project is part of the planning for an extended new network of distribution lines in this state.

The Institute achieved a remarkable feat by successfully completing the comprehensive first phase of the contract, which comprised the development and construction of equipment, in eight months instead of the approximately twelve months agreed on initially, at the request of the sponsor. The equipment was subsequently despatched to Minas Gerais, where the site for the lightning research station had been prepared by the company concerned prior to the commissioning of the equipment. Representatives of the Institute, and of the South African industrial concern which had been responsible for the manufacture of a digital measuring system for the project, and which had col-

laborated closely with the Institute, visited Minas Gerais to assist with the installation, integration and commissioning of the integrated systems.

The Institute's team was also responsible for the training of representatives of the Brazilian group.

Overseas offices

Owing to the extremely unfavourable rate of exchange between the rand and especially the dollar, there has been a sharp increase in the running costs of the overseas offices. The CSIR was therefore forced to close its office in Los Angeles. The Washington office will now deal with all matters concerning North America.

People

Visitors

Prof. C J Altstetter, Professor of Physical Metallurgy in the Department of Metallurgy and Mining Engineering, University of Illinois at Urbana-Champaign, spent six months in the Metals Division of the National Institute for Materials Research as a CSIR Fellow. During this time he was active in the alloy development research programme and presented a series of lectures at the CSIR and local universities.

Dr C A Brooks, Reader in Engineering Science from the University of Exeter in the U K, spent five months' sabbatical leave with the National Institute for Materials Research. During his time in South Africa, Dr Brooks collaborated with researchers in the Metals Division and also gave a series of research seminars for the materials community.

Professor Kan-Nan Chen, Chairman of the Department of Chemistry at Tamkan University in Tamsui, Taiwan, spent a month at the Inorganic Chemistry Division of the National Chemistry Research Laboratory in terms of the CSIR-NSC exchange programme.

Mr M D'Almeida, a senior representative of the Companhia Energética de Minas Gerais, an electricity supply company in Brazil, visited the National Electrical Engineering Research Institute for approximately two months in connection with a contract for the supply and installation of equipment to be used for a lightning parameter research project in Brazil.

Two scientists from the Republic of China, **Dr C F Den**, Director of the Division of Applied Science and Engineering, National Science Council in Taipei, and **Miss G Chen**, Senior Programme Manager of the same Division, visited South Africa for two weeks and investigated the possibilities of collaborating with certain CSIR institutes.

Professor Helmut Dörfel, Head of Research at the firm BASF in West Germany, and the Board members responsible for BASF's research effort world-wide, visited the CSIR in the year under review. They were informed of research at the National Chemistry Research Laboratory and the National Institute for Materials Research, the Energy Programmes of the Foundation for Research Development and the activities of the South African Inventions Development Corporation.

Mr T P Dudli, the Consul-General of the Swiss Consulate in Johannesburg, and **Mr H P Egger**, the Consul, visited several CSIR Institutes. They became acquainted with specific research projects and with the general standard of research work at the CSIR.

Mr C Gary of Electricité de France visited South Africa at the invitation of the National Electrical Engineering Research Institute in September for discussions concerning the exchange of expertise in the field of high-voltage and lightning research.

Dr Manfred Gindle of the editorial staff of a leading West German engineering weekly, held discussions with representatives of certain institutes during a visit to the CSIR. He was particularly interested in the economic implications for South Africa of the CSIR's research.

Prof. J B Goodenough of the Inorganic Chemistry Laboratory at Oxford University, UK, visited the National Institute for Materials Research and South African universities from 15 to 30 April as a consultant. He provided input of critical importance to research programmes and overall strategy for the Institute.

Prof. H L Hartnagel of the Technische Hochschule Darmstadt, an expert in the field of high-frequency techniques and gallium arsenide components, gave a series of lectures at the National Electrical Engineering Research Institute during March, and also visited the universities of Port Elizabeth and Stellenbosch.

Dr B Ives, President of the American Society for Metals (ASM), and **Mr D Walter**, an executive member of the ASM, paid a visit to the CSIR. Dr Ives, who is Professor of Metallurgy and Materials Science at McMaster University in Hamilton, Canada, gave a lecture on electro-chemical passivation of nickel-molybdenum alloys.

Prof. A G K Lutsch, professor emeritus of the Rand Afrikaans University and former advisor to the National Electrical Engineering Research Institute in the field in semiconductor technology, visited the Institute for a period of two months to participate in a project entailing a study of the formation of conducting silicide layers on silicon.

Sir Jack Lewis, Scientific Adviser to the British Prime Minister, Professor of Chemistry and Warden of Robinson College at the University of Cambridge, spent two days during his visit to South Africa holding discussions with researchers of the Inorganic Chemistry Division at the National Chemical Research Laboratory.

Professors Moshe and Nava Narkis of the Israel Institute of Technology were invited to spend two months participating in research projects at the CSIR. They worked at the National Building Research Institute and the National Institute for Water Research respectively.

Dr P Noel, an engineer at the Centre National d'Etudes Spatiales (CNES) in France, visited the CSIR. He gave a lecture at the CSIR Conference Centre on the positioning and station keeping of TDF 1, a television broadcasting satellite. He spent some time at the Satellite Remote Sensing Centre at Hartebeesthoek where he explained the operation of the satellite.

People

Professor Joseph J Rotman of the University of Illinois in the USA visited the National Research Institute for Mathematical Sciences as part of a one-month tour of South Africa. He also lectured in Cape Town, Stellenbosch, Durban, Pietersburg, Bloemfontein and Johannesburg.

Mr H Schoeman, Minister of Transport Affairs, delivered the opening address at the annual Transportation Convention which was held at the CSIR Conference Centre from 29 July to 2 August.

Professor Samuel Sideman, a world-renowned expert in biomedical engineering, visited South Africa as a guest of the CSIR. He is head of the Julius Silver Institute for Biomedical Engineering Sciences at the Israel Institute of Technology where he is responsible for an inter-disciplinary medical research programme.

Mr J W E Wiley, Minister of Environment Affairs and Tourism, accompanied by **Mr J F Otto** and **Mr W F Visagie**, the Director-General and Deputy Director-General of Environment Affairs, were informed about research related to effective management of the coastal region during a visit to the National Research Institute for Oceanology.

Staff

Mr J Churms was appointed Deputy Director of the South African Astronomical Observatory with effect from January 1985. He is involved in astronomical research which deals with the measurement of the position of heavenly bodies and the trigonometric determination of the distance between stars.

Dr J B Clark, Chief Director of the National Institute for Materials Research, was appointed as a Deputy President. He will join the CSIR Executive in 1986.

Mr P de Schaepdrijver was promoted to Deputy Director of the National Food Research Institute. He is also Head of the Brewing Technology Division of the Sorghum Beer Unit.

Mr P J van der Westhuizen of the Foundation for Research Development was appointed as Counsellor (Science) in Paris with effect from 1 April of the year under review.

Mr A H van Tonder, Head of the Fluid Mechanics Division of the National Mechanical Engineering Research Institute, was appointed Deputy Director of the Institute with effect from January 1985.

Merits

Dr H Booyens and his wife **Dr J H Basson**, who both work at the National Institute for Materials Research, received the Silver Jubilee Medal from the South African Institute for Physics. It is awarded annually to a researcher younger than 35 years of age for special achievements in physics.

Miss F A Cameron of the National Timber Research Institute and **Dr A Pizzi**, Chief Director of the Institute, received the Markwardt Award for Timber Engineering from the American Forest Products Research Society for their work on the development of quick-setting adhesives and their application in the production of laminated wood.

Dr J B Clark, Chief Director of the National Institute for Materials Research, was one of the four Outstanding Young South Africans to receive the FOYSA award for 1985. This award is presented annually to four South African citizens between the ages of 21 and 40 who have made significant contributions for the benefit of all the peoples of South Africa. Dr Clark is regarded as a pioneer in the field of metal alloy phase diagrams under high pressure. He also received an honorary professorship in the Department of Metallurgy of the University of the Witwatersrand.

The Tom Rozwadowski medal of the Operations Research Society of South Africa was presented to **Mr D C Currin** and **Mr H W Ittmann** of the Operations Research and Statistics Division of the National Research Institute for Mathematical Sciences, at the annual conference of the Society held in Pietermaritzburg from 16 to 17 September 1985. The medal was presented to them for their work on a production planning system for the South African Breweries. This is an interactive management support system that assists in the planning of beer brewing, packaging and distribution on an annual basis.

Dr A J Eriksson, the Programme Leader for Power Systems Technology at the National Electrical Engineering Research Institute, was made Honorary Professor in the Department of Electrical Engineering at the University of the Witwatersrand. He is known locally and internationally for his work on high voltage and lightning.

Mr J H J Filter, **Dr J C Vogel** and **Dr A Pizzi** received the Council's Merit Prizes for 1985. These prizes are awarded annually to acknowledge and reward outstanding professional work of local and international value by CSIR scientists.

Mr Filter, a Director of the National Electrical Engineering Research Institute has, during the past 15 years, contributed greatly in the field of signal processing towards the

People

development of many items of unique and improved equipment required for specific purposes in the national interest.

Dr Vogel, Head of the Natural Isotopes Division of the National Physical Research Laboratory, is world-renowned for his work on natural isotope research and a wide range of applications he pioneered in such diverse fields as archaeology, oceanology, ecology, hydrology and geology.

Dr Pizzi, Chief Director of the National Timber Research Institute, has been awarded the prize because of his internationally recognized work on wood adhesives and water borne wood preservatives.

Dr C R Freeme of the National Institute for Transport and Road Research received an award from the Council of the South African Institution of Civil Engineers in recognition of his and his team's research on heavy vehicle simulation. He was also the first recipient of the CAPSA Research Award. Dr Freeme was responsible for the development of new economic designs for bituminous treated bases and made important contributions towards the development of pavement rehabilitation design procedures.

Dr W O K Grabow of the National Institute for Water Research was invited by the Pan American Health Organization to Brazil to advise the responsible authority there on matters concerning water quality.

In 1983 Dr Grabow did research for a six-month period at the Pettenkofer Institute in Munich on the hepatitis A virus which causes infectious jaundice. One of the highlights of Dr Grabow's research during the past few years was the development of an affinity chromatographic technique for selective detection of the virus in water.

Dr D M Hawkins, a senior consultant of the National Research Institute for Mathematical Sciences, was one of three recipients of the Claude Harris Leon Foundation Award for 1985. Dr Hawkins received the award in recognition of his contributions towards the development of new and improved methods concerning the outlier theory of statistical analysis, and also for his special achievements in applying these methods in the fields of mining, market research and pharmaceuticals.

Mr H W Ittmann of the National Research Institute for Mathematical Sciences received the Old Mutual Gold Medal for the best MBA student of the Post-graduate Management School at the University of Pretoria.

Dr S H Kühn, Chief Director of the National Institute for Transport and Road Research, was invited to become a member of the Board of Patrons of the Institute for Futures Research at the University of Stellenbosch.

Dr E V Macagnano of the National Building Research Institute received the Boumat award for his objective and successful work on the design of buildings for the accommodation of the aged.

Mr R J Page-Shipp, a Director of the National Building Research Institute, received the Bester Merit Award for his leadership in the Institute's research on human indoor environmental requirements and the formulation of appropriate standards for low-cost housing.

Dr A Pizzi, Chief Director of the National Timber Research Institute, and **Mr W Conradie**, Head of the Institute's Preservation Section, made contributions towards a book entitled *Wood Preservation in Southern Africa*.

The book, which is one of a series published by the Swedish Institute for Wood Preservation, includes information on timber production, timber-destroying organisms and wood preservation in Southern Africa.

Dr F R Schoeman of the National Institute for Water Research was invited to attend the Eighth International Symposium on Living and Fossil Diatoms in September 1984 in Paris, France. Dr Schoeman made valuable contributions towards a comprehensive textbook on the diatoms of Southern Africa which has already been published. His work on diatom taxonomy has gained international recognition for the Institute.

Mr G C Simpson of the National Building Research Institute received the J D Roberts Merit Award for his outstanding research on water economy.

Dr S A Smithies of the National Electrical Engineering Research Institute was made Honorary Professor of Microelectronics in the Department of Electronic Engineering at the University of Natal.

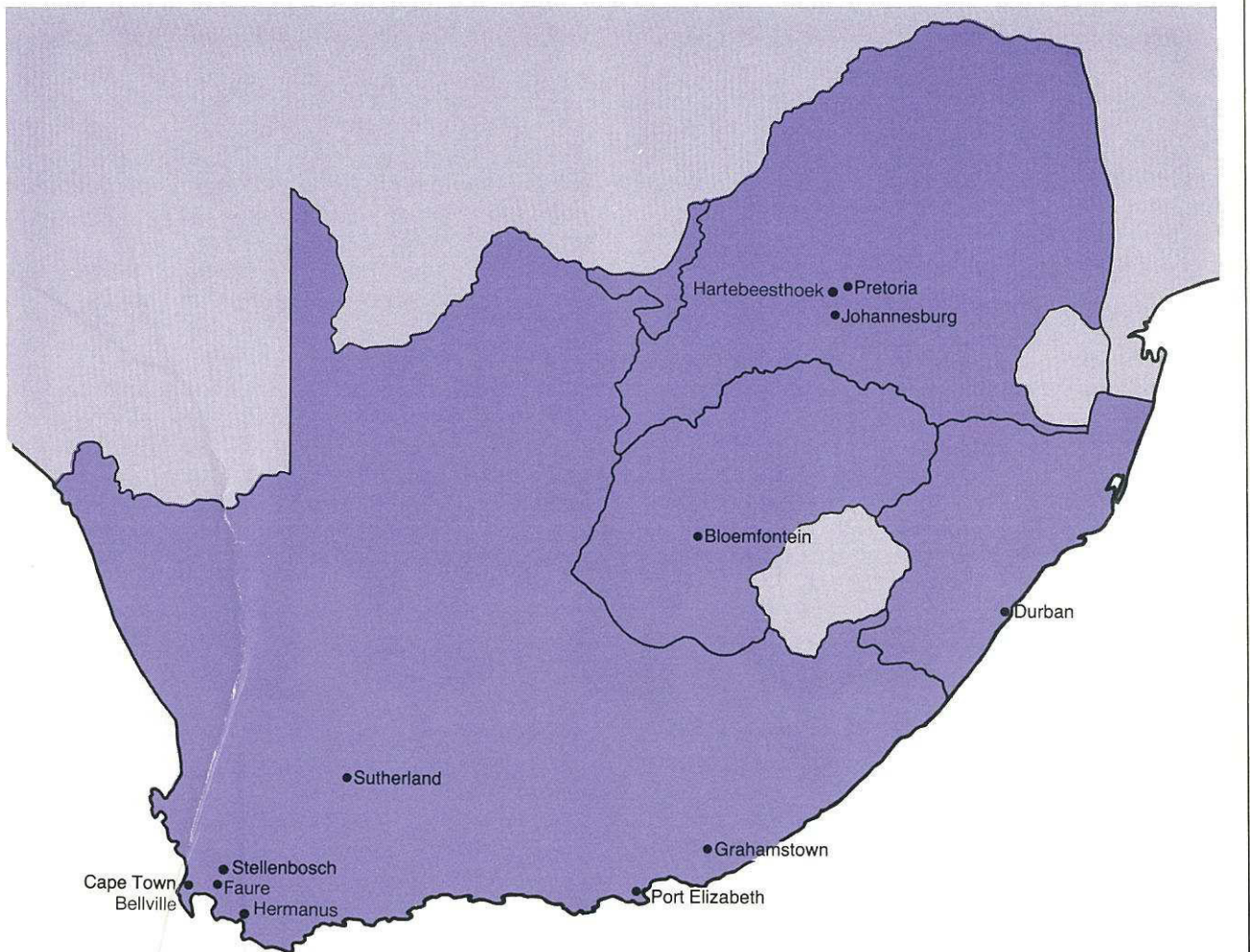
Mr I le R Strydom of the National Institute for Materials Research received the SMM Award of the South African Institute for Physics for his publication *The composition and bonding characteristics of the alloying elements in electrodeposited Ni-G alloys*.

Mr J L Waldeck of the National Building Research Institute received the J D Roberts Merit Award in recognition of his research on the effects of wind force on full-scale buildings, especially on tall chimneys.

Dr A A B Williams, Head of the Structural and Geotechnical Engineering Division of the National Building Research Institute, gave a series of lectures on soil surveying in Cochabamba, Bolivia, as member of a training team. The lectures were based on the book *Soil survey for engineering*, which was co-authored by Dr Williams.

It was found that soil surveying techniques developed in South Africa could be applied very well in a Third World country. After the course it was proposed that the book should be translated into Spanish for use in South America and that further courses should be given in Bolivia.

Organization and functions of the CSIR



Pretoria

- ACU — Applied Chemistry Unit
- CERG — Chemical Engineering Research Group
- FRD — CSIR Foundation for Research Development
- IRS — Information and Research Services
- NBRI — National Building Research Institute
- NCRL — National Chemical Research Laboratory
- NEERI — National Electrical Engineering Research Institute
- NFRI — National Food Research Institute
- NIAS — National Institute for Aeronautics and Systems Technology
- NICR — National Institute for Coal Research
- NII — National Institute for Informatics
- NIMR — National Institute for Materials Research
- NITRR — National Institute for Transport and Road Research
- NIWR — National Institute for Water Research
- NMERI — National Mechanical Engineering Research Institute
- NPRL — National Physical Research Laboratory
- NRIMS — National Research Institute for Mathematical Sciences
- NTRI — National Timber Research Institute
- TSD — Technical Services Department

SAIDCOR — South African Inventions Development Corporation

Johannesburg

- NITR — National Institute for Telecommunications Research

Hartebeesthoek

- SRSC — Satellite Remote Sensing Centre
- RAO — Radio Astronomy Observatory

Sutherland

- SAAO — South African Astronomical Observatory

Cape Town

- SAAO — South African Astronomical Observatory

Faure

- NAC — National Accelerator Centre

Stellenbosch

- NRIO — National Research Institute for Oceanology

Hermanus

- MO — Magnetic Observatory

Port Elizabeth

- SAWTRI — South African Wool and Textile Research Institute

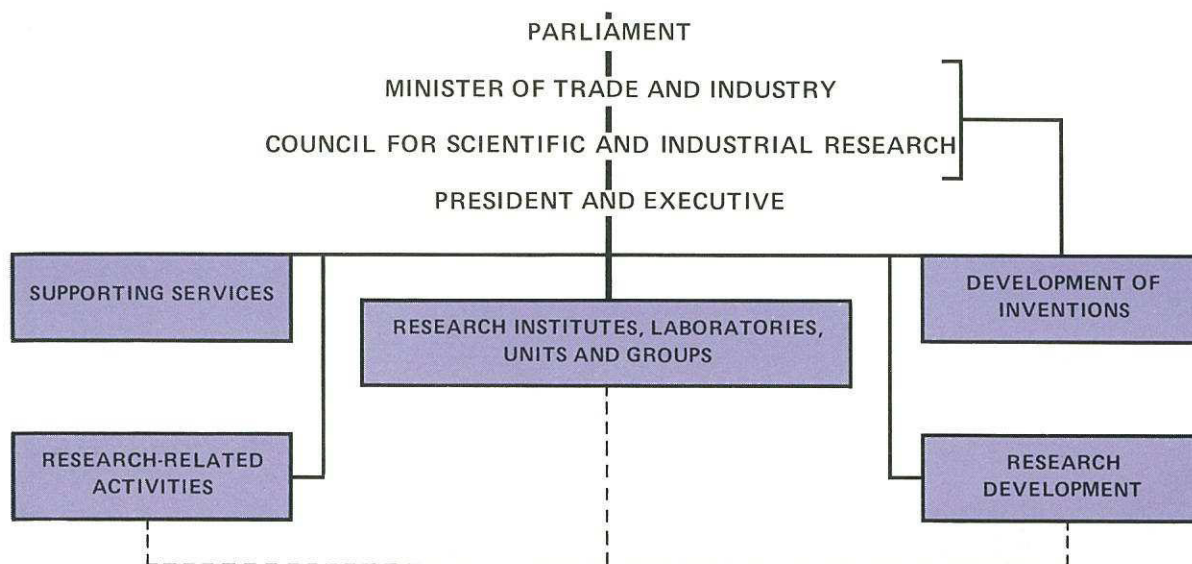
Regional Representation

- Johannesburg
- Bloemfontein
- Cape Town
- Bellville
- Port Elizabeth
- Durban

Industrial Research Institutes

- FIRI — Fishing Industry Research Institute (Cape Town)
- LIRI — Leather Industries Research Institute (Grahamstown)
- SMRI — Sugar Milling Research Institute (Durban)

Organization and functions of the CSIR



NATIONAL CHEMICAL RESEARCH LABORATORY

Chief Director: Dr J R Bull

The National Chemical Research Laboratory (NCRL) is a centre at which the latest developments in chemical science are brought to bear on problems of national significance.

In accordance with its policy, namely of concentrating on research in fields where there is a need for more basic knowledge, many of the Laboratory's research projects are carried out in collaboration with research organizations that are more directly concerned with the application and exploitation of research findings. Well-motivated long-term projects are therefore approached from a fundamental point of view. The Laboratory is also responsible for providing advanced research services to chemists in South African universities and industrial laboratories.

The NCRL is organized into divisions for analytical chemistry, inorganic chemistry, molecular biochemistry, structural chemistry and organic chemistry.



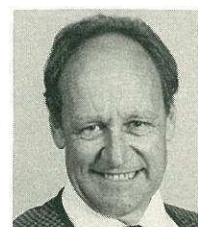
NATIONAL PHYSICAL RESEARCH LABORATORY

Chief Director: Dr J S V van Zijl

The activities of the National Physical Research Laboratory (NPRL) are determined by the industrial and national needs of the Republic of South Africa. Research and development is undertaken in the various fields of the natural sciences, including optics, solid state physics, geophysics, acoustics, geochronology, atmospheric physics and natural isotopes. The research is usually carried out in fields of application where a need for further knowledge exists or is anticipated, but it can also be of a more fundamental nature.

The NPRL is organized into two main research groups dealing with General Physics and Earth and Atmospheric Sciences, each of which consists of a number of key divisions staffed by specialist researchers. Proficiency is required in highly advanced techniques, and personnel of the NPRL have to be especially conversant with those involving physical measurements and methods in order to make a meaningful contribution.

In addition, in terms of Act 76 of 1973, the NPRL has statutory responsibility for the maintenance of the national measuring standards of mass, length, time, temperature, electricity, light, ionizing radiation, force and pressure.



Organization and functions of the CSIR

NATIONAL ACCELERATOR CENTRE



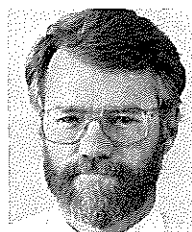
Chief Director: Dr D Reitmann

In 1977 the CSIR accepted the responsibility of establishing the National Accelerator Centre (NAC) with the commission to provide multidisciplinary accelerator facilities for the use of all scientists in the country who are interested in research with and the application of beams of accelerated particles. The NAC consists of two groups, one near Faure whose main responsibilities at present are the construction of a separated-sector cyclotron facility with a maximum energy of 200 MeV per nucleon and the operation of a 6 MeV Van de Graaff accelerator, and another in Pretoria, using the CSIR cyclotron there.

The objectives of the NAC in broad terms are:

- to provide facilities for basic and applied research using beams of accelerated particles;
- to provide service facilities in South Africa for particle therapy and clinical trials in various treatment methods;
- to supply accelerator-produced radioactive isotopes to users in nuclear medicine, research and industry.

NATIONAL RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCES

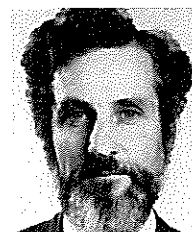


Chief Director: Dr D H Martin

The National Research Institute for Mathematical Sciences (NRIMS) consists of divisions for numerical and applied mathematics, mathematics and dynamic meteorology, computer science, operations research and statistics, and theoretical physics.

Research activities cover the various mathematical sciences and their applications. Typical fields of study are theoretical nuclear physics, differential equations, control theory and optimization, statistical analysis techniques, methods of operations research, numerical analysis, interactive computer graphics and special programming languages.

SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

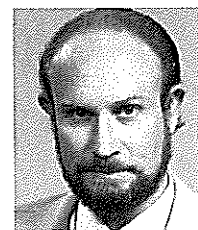


Chief Director: Prof. M W Feast

The South African Astronomical Observatory (SAAO) is operated jointly by the CSIR and the Science and Engineering Research Council of Great Britain. The Headquarters of the SAAO are situated in the grounds of the former Royal Observatory in Cape Town. A major observing facility equipped with modern instrumentation has been established at Sutherland in the Karoo. The large number of clear nights each year and the absence of smog and city lights make this an excellent site for astronomical observations.

Besides being the National Observatory of South Africa, the SAAO provides observing facilities for astronomers from Great Britain and the South African universities. Staff and visitors carry out research on a wide variety of astrophysical problems such as the chemical composition of stars, the nature of stellar pulsations, the size and structure of our Galaxy, the extra-galactic distance scale, active galaxies and quasars. Investigations are also carried out in collaboration with space and radio astronomers.

MAGNETIC OBSERVATORY



Head: Dr G J Kühn

The Magnetic Observatory at Hermanus is an important link in a world-wide network of organizations engaged in studies of the behaviour of the magnetic field of the earth. For this purpose the Observatory operates a chain of four magnetic recording stations extending from Tsumeb in the north to Sanae (Antarctica) in the south. As there is a direct interaction between variations of the magnetic field and the motion of charged atomic particles in the magnetosphere, particle related geophysical phenomena (such as the aurora) are also recorded and studied as part of the research programme of the Observatory.

In addition to its continuous monitoring programmes, the Observatory conducts regular country-wide surveys for the purpose of compiling magnetic charts for Southern Africa.

Organization and functions of the CSIR

Attention is also given to the use of satellite magnetic data for magnetic field modelling and for the mapping of crustal magnetic anomalies in Southern Africa.

The research programme of the Observatory embraces the study of disturbed conditions in the magnetosphere, including magnetic pulsations and magnetic substorm phenomena, as well as the study of the nature of regular quiet-time variations of the magnetic field. Variations of the magnetic field are also used by means of the so-called magneto-telluric method to study the electrical properties of material in the crust of the earth.

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY

Chief Director: F P Anderson

The National Research Institute for Oceanology (NRIO), which has its headquarters at Stellenbosch, is a multidisciplinary organization in which all marine and coastal engineering sciences are represented. The research divisions are supported by a full range of services required to run a large institute remote from CSIR headquarters in Pretoria.

The coastal zone of South Africa is under severe pressure due to a growing population and its increasing affluence, and the Institute puts much effort into studying all aspects of this area in order to understand its natural functioning and predict man's impact on it. The dynamics of the Southern Ocean are also studied to determine the role of this ocean in Southern African weather and climate.

NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Chief Director: Dr M S Hunt

The National Mechanical Engineering Research Institute (NMERI) deals mainly with the development of mechanical engineering processes and techniques, and the improvement of machinery, plant designs and materials used in industry. The Institute is also active in civil engineering,

hydraulics and geomechanics, which play an important role in mining and civil engineering.

The laboratories of the Institute at Scientia, Pretoria, accommodate divisions for design and development, tribology, strength mechanics, geomechanics, fluid mechanics, aeromechanics and heat mechanics (including air-conditioning and refrigeration). The Mine Equipment Research Unit in Cottesloe, Johannesburg, which deals mainly with the safety of mine hoist ropes, is also part of the Institute.

The Production Engineering Advisory Service (PEAS) which used to be part of the Technical Services Department was transferred to the Institute on 1 October 1984. The unit is active in the fields of production engineering, machining technology and machine development.



NATIONAL ELECTRICAL ENGINEERING RESEARCH INSTITUTE

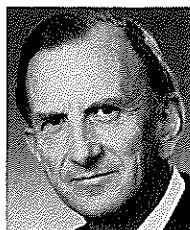
Chief Director: J D N van Wyk

The National Electrical Engineering Research Institute (NEERI) undertakes research and development in widely differing fields of electrical engineering with a research programme which covers the broad technology fields of cybernetics, microelectronics and power systems.

The dynamic nature of NEERI's research programme is reflected in its flexible management structure, which allows the most advantageous grouping of individual activities to accommodate immediate needs and to allow for shifts in emphasis.

The research activities are grouped into three broad technology fields, namely cybernetics (which encompasses digital systems technology and industrial technology), microelectronics, and power systems. Each programme is directed by a Programme Leader, assisted by a Programme Manager and various Divisional Heads, and these three programmes are co-ordinated ultimately by the Chief Director.

In addition to the research activities, a number of special facilities and services are also maintained and provided by the Institute. These include, amongst others, maintenance and calibration services for specialized electronic equipment, as well as facilities for the design and manufacture of integrated circuits and the computer-aided design of printed circuit boards. Finally, the Institute undertakes the practical training of diploma technicians in electronic engi-



Organization and functions of the CSIR

neering for the CSIR and maintains a national information service on electronic instrumentation.

CHEMICAL ENGINEERING RESEARCH GROUP

Head: W G B Mandersloot

The field of chemical engineering deals with the processes and operations by which the properties or composition of matter in bulk are changed. The activities of the Chemical Engineering Research Group (CERG) cover not only the needs of the chemical industry, but also many processing aspects of the petroleum, petrochemical, mineral, food, beverage, biochemical, pharmaceutical, ceramic, paper and textile industries and environmental technology (in which water, effluent and air are important). Owing to the interdisciplinary nature of chemical engineering, collaboration with other institutes and organizations is important.

The research and development items on the programme of the Group are selected according to the immediate and anticipated needs of industry. The main subjects are heat and mass transfer, properties of fluids, energy utilization in the process industry (particularly in drying), fluid dynamics, particle technology, reactor technology and catalysis, and prevention of air pollution. The Group provides the industrial sector with a wide range of consulting services which can, if necessary, be supported by applied or fundamental research.



NATIONAL BUILDING RESEARCH INSTITUTE

Chief Director: Dr J Morris

The National Building Research Institute (NBRI) with a staff complement of some 240 people, has its headquarters in Pretoria and regional offices in Cape Town, Bloemfontein, Durban and Port Elizabeth. Its annual budget of some ten million rand is approximately one-tenth of one per cent of the amount spent on building and construction in South Africa every year. About one-third of its total budget is earned by services rendered to the building community.



The Institute's 10 divisions cover a wide range of research fields but areas selected for special emphasis in the first half of this decade are -

- housing, particularly in the low income sector;
- school buildings, with special reference to the backlog in and special needs of Black education;
- promotion of human health, productivity and safety via design and planning of buildings and building services;
- conservation and development of material and energy resources.

The effective application of research results in the building industry is one of the Institute's high priority objectives.

NATIONAL INSTITUTE FOR WATER RESEARCH

Chief Director: Dr D F Toerien

Water research is essential to a country such as South Africa where water is the most vital limiting factor in socio-economic growth. The task of the National Institute for Water Research (NIWR) is to promote optimum use of available water resources. Its activities include investigations into water purification, the treatment of effluent to meet the requirements of specific norms and the various types of pollution encountered in dams, rivers and estuaries.

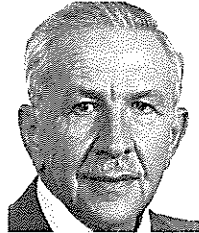
The Institute has a total staff of 203, is divided into a number of research divisions and has branch laboratories in Durban and Bellville. Basic and applied research on a wide range of problems concerning the country's water supplies is done on a multidisciplinary basis. Research divisions have been established for limnology, water quality, biotechnology, process technology, appropriate technology, solid wastes, groundwater quality, estuaries and coastal regions. Another division renders advisory services on water care.



Organization and functions of the CSIR

NATIONAL INSTITUTE FOR TRANSPORT AND ROAD RESEARCH

Chief Director: Dr S H Kühn

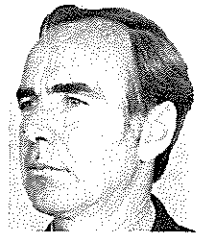


Transport and road authorities encounter a wide range of problems in their endeavours to ensure the most economical use of transport facilities as a public amenity. The research programme of the National Institute for Transport and Road Research (NITRR) is directed at finding solutions to these problems through research into the planning, design, construction, maintenance and operation of roads and transport systems, road safety and the behaviour of road users, and the role of roads and transport in society. Another important function of the NITRR is to ensure the effective dissemination and application of research findings throughout the transport industry.

The NITRR works in close collaboration with national and provincial transport and road authorities, the South West Africa Administration, the South African Transport Services, the National Road Safety Council and the road and transport industries, which together provide most of the funds for research.

NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

Chief Director: R W Vice



The National Institute for Telecommunications Research (NITR) carries out research and development in radio science and its applications. The work of the Institute falls under five research divisions.

The Radiocommunications Division is concerned with the prediction of the performance of communications systems under various environmental conditions.

The Systems and Circuits Division develops radio and radar systems for specialized applications, an example being the development of microwave distance measuring equipment.

The Radiometeorology Division carries out research into the use of radar in the measurement of rainfall and the observation of storm dynamics. It also conducts a programme of lightning research using radio techniques.

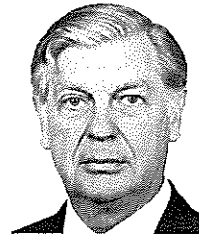
A programme of radio astronomy is carried out by the

Radio Astronomy Division. The facilities include a 26-m radiotelescope and the associated radiometers.

The Satellite Remote Sensing Centre is responsible for the acquisition, processing and distribution of satellite data and imagery of the earth's surface and atmosphere. It is principally involved with data from the Landsat and Meteosat satellites and with the tracking of satellites on behalf of the French Centre National d'Etudes Spatiales.

NATIONAL INSTITUTE FOR AERONAUTICS AND SYSTEMS TECHNOLOGY

Chief Director: Dr T J Hugo

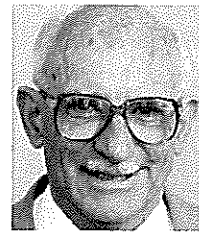


The National Institute for Aeronautics and Systems Technology (NIAST) consists of laboratories for electronics, systems, aeronautics and electrical support. Its task is to develop technological expertise in these fields for the benefit of the relevant industries.

The Institute's main activities are concentrated on flight dynamics, aerodynamics, aircraft structures, propulsion, servo-mechanisms, and digital and microwave systems. Multidisciplinary projects, some involving extensive systems analyses, are also undertaken.

NATIONAL FOOD RESEARCH INSTITUTE

Chief Director: Dr L Novellie



The main aim of the National Food Research Institute (NFRI) is to promote effective utilization of South Africa's food resources. The Institute consists of five research divisions: Food Chemistry, Food Technology, Biological Evaluation, Fermentation Technology, and Oils and Fats, and it also administers and is closely associated with the CSIR's Microbiology Research Group and Sorghum Beer Unit.

Typical fields in which fundamental and applied research are carried out are processing of subtropical crops, cereal technology and biochemistry, food processing and storage, lipid chemistry and technology, food microbiology, food analysis, fermentation processes and brewing technology. Biological studies of the utilization of nutrients in foods and diets are also undertaken.

Organization and functions of the CSIR

SOUTH AFRICAN WOOL AND TEXTILE RESEARCH INSTITUTE

Chief Director: Dr D W F Turpie

The South African Wool and Textile Research Institute (SAWTRI) in Port Elizabeth conducts research on those natural fibres - particularly wool, cotton and mohair - that are of major importance to the South African fibre producers and textile industry. Blends of these natural fibres with synthetic fibres are also studied.

In essence the Institute is a self-contained experimental textile factory with processing facilities enabling it to process almost any staple fibre from the raw state to the garment stage on full-scale machinery.

Textile research is aimed at improving our knowledge and understanding of locally produced textile fibres, their behaviour during processing and their end use for the benefit of the fibre producer, the textile manufacturing industry and the consumer. Greater efficiency in the processing, dyeing and finishing of textiles is an important goal, which sometimes necessitates further development of existing processing machinery as well as the designing of new machines and instruments. Another important aim of the research programme is to impart to the final product the aesthetic and technical qualities, particularly easy-care properties, that are now being demanded by the discerning customer.

Finally, the Institute provides an important service in assisting the textile industry with trouble shooting and problem solving.



The research is conducted in close collaboration with the timber processing industry to ensure that the results are applied and products manufactured which are acceptable to the consumer in terms of sophistication, quality and price.

Approximately one third of the Institute's budget of R3,3 million is derived from the timber processing industry.

NATIONAL INSTITUTE FOR MATERIALS RESEARCH

Chief Director: Dr J B Clark

The National Institute for Materials Research (NIMR) carries out directed research and development in the fields of ceramics, electronic materials and metals (and polymers - under development) to support industrial needs, and, wherever possible, to exploit the national materials potential. Special emphasis within this multidisciplinary environment is thus given to developing import replacement technologies, finding new applications for South African raw and engineering materials and promoting their export and wider utilization. A primary objective is to establish joint ventures with industry to implement research results by technology transfer.

The research focuses on the structure-property relationships of materials and how these can be manipulated and optimised by processing, as well as on the performance of materials in engineering systems. Expertise and facilities of the highest international standards are used to promote materials science and engineering in South Africa.



NATIONAL TIMBER RESEARCH INSTITUTE

Chief Director: Dr A Pizzi

The aim of research and development work at the National Timber Research Institute (NTRI) is to make available knowledge and expertise which will help the timber processing industry to make maximum use of South Africa's timber resources.



NATIONAL INSTITUTE FOR COAL RESEARCH

Chief Director: Dr T C Erasmus

The National Institute for Coal Research (NICR), formerly the Fuel Research Institute of South Africa, was incorporated into the CSIR on 1 April 1983.

The Institute has three divisions, the Chemistry, Engineering and Survey Divisions, at the Lynnwood Road com-



Organization and functions of the CSIR

plex, extensive pilot plant facilities at Research Road, Pretoria West, and a station for the sampling of export coal at Durban.

The three divisions conduct basic and applied research, both in the national interest and under contract to the coal industry and government departments.



APPLIED CHEMISTRY UNIT

Head: Dr V P Joynt

The Applied Chemistry Unit (ACU) is an independent CSIR unit largely financed on a contract basis by outside organizations to undertake studies on the application of chemistry to various production and engineering problems.

These studies are frequently joint programmes in which the sponsors second staff to the Unit to contribute directly to the research and development effort.



TECHNICAL SERVICES DEPARTMENT

Head: Mr P Lasserre

The Technical Services Department (TSD) designs and manufactures research equipment and renders essential services such as graphic arts, transport and stores to the laboratories and institutes of the CSIR.

The Department also undertakes work on contract for other bodies and industry if the work cannot be done anywhere else in the Republic.



INFORMATION AND RESEARCH SERVICES

Chief Director: Dr L R P Butler

The Information and Research Services (IRS) is the corporate liaison activity within the CSIR with the following objectives:

- to act as the central liaison and communication centre for the CSIR;
- to promote the corporate image of the organization;
- to provide a management information service, both financial and techno-economic, for scientific and technology decision makers and strategy planners within the CSIR and elsewhere;
- to liaise closely with industry to promote research and development, as well as to encourage interaction with research bodies;
- to provide direct and indirect techno-economic support for stimulating development in the local manufacturing sector;
- to communicate the major scientific and technological successes and achievements of the CSIR to the public, private and educational sectors;
- to promote international scientific relations and represent South Africa in the field of science and technology overseas.



NATIONAL INSTITUTE FOR INFORMATICS

Chief Director: V A Shaw

The National Institute for Informatics was formed in September 1984 by the merging of the Centre for Scientific and Technical Information and the Centre for Computing Services.

This merger indicates recognition by the CSIR of the increasing importance and mutual interdependence of information and computing technologies.

While some rationalization in the organizational structure has taken place and closer collaboration between the information and computing technologies has been imple-

Organization and functions of the CSIR

mented, the two services will retain their identities as the Centre for Scientific and Technical Information and the Centre for Computing Services.

The Centre for Scientific and Technical Information (CSTI) has as its general objective the promotion of use of scientific and technical information, in terms of the Scientific Research Council Act, which states that it is one of the functions of the CSIR 'to establish and control facilities for the collection and dissemination of information in connection with scientific and technical matters'.

To achieve this objective, the CSTI's main functions are as follows:

- the provision of information and library services to CSIR staff and to users outside the CSIR;
- the promotion and/or provision of information and library services to scientific and technical organizations and to industry;
- the undertaking of applied research in the library and information field.

The Centre for Computing Services (CCS) provides for the computing requirements of all CSIR institutes and carries out research to develop and support this function.

The computing facilities consist of three large central processors at Scientia and a smaller one at Faure, serving some 25 CSIR institutes, laboratories, units and groups situated in various parts of the country. Research workers have access to these facilities, directly or via some 400 terminals, or via minicomputers or remote job entry stations linked to the central computers through a data communications network.

A wide range of software for interactive working, data base management, file and data management and for various applications is available on these systems.

The Centre also provides the necessary supporting services such as program guides and other information, training courses and a consulting service for its users.

University research projects approved by the CSIR Foundation for Research Development are also granted time on the CSIR computers and in particular circumstances, and subject to certain conditions, facilities are made available to outside bodies.



FOUNDATION FOR RESEARCH DEVELOPMENT

Head: Dr R R Arndt (Deputy President)

The Foundation for Research Development (FRD), which was formed in April 1984 to combine the functions of the former Cooperative Scientific Programmes (CSP) and the Research Grants Division (RGD), is responsible for the development of research in the natural and applied sciences in South Africa.

The funds provided by the State to support own-choice research at universities, museums and technikons is administered in terms of the Main Research Support Programme (which continues the work of the RGD). These funds are awarded to postgraduate students and established researchers on the basis of individual merit by the Main Research Support Programme's Advisory Committee and its various specialist subcommittees.

The National Programmes (previously the CSP) are aimed at solving well-defined national problems through co-operative research. Here the objectives of the proposed research and the quality of the research team are the criteria for support. The National Programmes were introduced to co-ordinate research efforts and to mobilize the best available expertise for research into complex interdisciplinary and multi-institutional problems of national and international importance that are unlikely to be solved by separate organizations working in isolation. Earlier programmes, several of which are still in existence, developed out of our participation in global ventures of the International Council of Scientific Unions (ICSU). Later programmes, on the other hand, are mainly focused on national needs.

The co-ordinators collaborate with scientists and managers of statutory organizations, government departments and the private sector in planning, harmonizing and developing these programmes.

Stimulation Support Programmes will be introduced to promote research not catered for by the existing programmes.

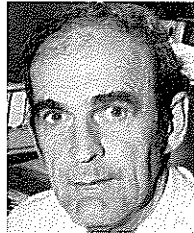
At present there are national programmes for the following fields of research: Oceanography (with programmes on the Benguela ecology, coastal processes, estuaries, marine pollution, marine linefish and marine sedimentology); Antarctic research (with sections for biological, earth, oceanographic and upper atmosphere sciences); environmental sciences (with sections for inland water ecosystems, terrestrial ecosystems and nature conservation research); geosciences; renewable feedstocks; wastes management (with sections for urban, chemical, mineral and organic wastes); energy (sections for energy in transportation, coal research, and alternative technology); re-

Organization and functions of the CSIR

mote sensing; weather, climate and atmosphere research; microelectronics; aquaculture; and biotechnology.

LEATHER INDUSTRIES RESEARCH INSTITUTE

Director: Dr D R Cooper



The Leather Industries Research Institute (LIRI) in Grahamstown is regarded as the pioneer of industrial research for South Africa's secondary industry. From its early beginnings in 1935 in the Chemistry Department of Rhodes University, the Institute has maintained a steady growth.

A feature of LIRI's work is the balance maintained between basic research and the application of science to the everyday technical problems of the industries served. A high rate of technology transfer has been achieved thanks to the close personal contact between the many subscribers and the frequency of factory floor contacts at all levels between research and production staff.

SUGAR MILLING RESEARCH INSTITUTE

Director: Dr A B Ravnö



The Sugar Milling Research Institute (SMRI) is the central scientific organization involved in research into the manufacturing problems of the South African sugar industry. It was established in 1949 by the South African Sugar Millers' Association Limited (SASMAL), the CSIR and the University of Natal, on whose campus it is situated in Durban. The Institute is financed by SASMAL and the CSIR.

In addition to all South African sugar mills, a number of sugar factories in neighbouring countries are also affiliated members of the Institute.

The main functions of the SMRI are as follows:

- Research into various aspects of the production of sugar from sugarcane, involving both basic chemical problems and the engineering aspects of factory design.
- Control and microbiological analysis of the sugar, mo-

- lasses and intermediate products of the factory.
- Advisory work on factory and industrial problems.
- Research into the utilization of by-products of the sugar industry.
- Dissemination of information on sugar manufacture and by-product utilization.
- Training courses in sugar technology for chemical engineering diplomates in collaboration with the Natal, M L Sultan and Mangosuthu Technikons.

(The sugar industry maintains a research station at Mount Edgecombe, Natal, where the cultivation of sugarcane is studied.)

FISHING INDUSTRY RESEARCH INSTITUTE

Director: Dr J P H Wessels



The Fishing Industry Research Institute (FIRI), which is affiliated to the University of Cape Town, is situated on the university campus.

The Institute is financed by voluntary contributions from the fishing industry and a subsidy from the CSIR. Firms which are indirectly connected with the fishing industry are eligible for associate membership of the Institute.

The affairs of the Institute are managed by a Board of Control on which the fishing industry, the CSIR, the Minister of Environment Affairs, the Fisheries Development Corporation of South Africa Ltd, and the Universities of Cape Town and Stellenbosch are represented. The research programme is planned and executed in consultation with specially appointed committees, the members of which are prominent technical personnel of the inshore and white fish industries.

The principal role of the Institute is to undertake fundamental and applied research on behalf of the fishing industry. This involves a variety of different products and processes, such as refrigerated and frozen whole rock lobster and rock lobster tails, canned pilchards and mackerel, fish meal, fish oil and the like.

The Institute also acts as a technical adviser to the industry on the purification of effluent, the control of odour, the testing of packaging materials and the purification of water for use in factories. Co-operation with international organizations such as the International Association of Fish Meal Manufacturers and the International Institute of Refrigeration ensures that the industry keeps pace with the progress taking place in every sphere of fish processing.

Financial statements

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

STATEMENT 1

BALANCE SHEET AT 31 MARCH 1985

| | General Fund R | Building Fund R | 1985 R | 1984 R |
|---|------------------------|----------------------|-----------------------------------|--------------------|
| <i>Accumulated funds:</i> | | | | |
| Balance brought forward | 140 183 873,00 | 83 324 309,59 | 223 508 182,59 | 179 704 617 |
| <i>Additions:</i> | | | | |
| Income over expenditure | 3 507 924,45 | — | 3 507 924,45 | 7 220 456 |
| Transfer of funds | (16 608,00) | 16 608,00 | — ¹ | — |
| Capital income (Note 1) | 25 654 369,96 | 13 988 059,00 | 39 642 428,96 | 34 974 798 |
| Physical assets and funds received | 9 158 592,87 | 2 801 440,00 | 11 960 032,87 ² | 4 468 209 |
| | 178 488 152,28 | 100 130 416,59 | 278 618 568,87 | 226 368 080 |
| <i>Reductions:</i> | 3 527 624,66 | 370 278,61 | 3 897 903,27 | 2 859 897 |
| Physical assets relinquished | 1 817 547,95 | 370 278,61 | 2 187 826,56 ³ | 363 721 |
| Physical assets written off | 1 710 076,71 | — | 1 710 076,71 | 2 496 176 |
| Total | R174 960 527,62 | 99 760 137,98 | 274 720 665,60⁴ | 223 508 183 |
| <i>Utilization of funds:</i> | | | | |
| Fixed assets (Note 2) | | | 242 395 988,56 | 201 764 276 |
| Balance brought forward | | | 201 764 275,54 | 167 495 060 |
| Net additions | | | 40 631 713,02 | 34 269 216 |
| Long-term leasehold | | | — ⁵ | 101 112 |
| Investments | | | 5 003 880,00 | 973 880 |
| Shares in SA Inventions Development Corporation | | | 5 000 000,00 | 970 000 |
| Escom Stock: 6,875% - 1992 | | | 3 880,00 | 3 880 |
| Net current assets | | | 27 320 797,04 | 20 668 915 |
| <i>Current assets</i> | | | 47 890 983,10 | 35 492 991 |
| Saleable stock | | | 267 077,05 | 150 364 |
| Debtors and debit balances | | | 12 146 580,85 | 10 434 928 |
| Advances and deposits: | | | | |
| Research grants | | | 308 364,79 ^{6a} | 4 944 178 |
| Other | | | 7 434 290,11 | 5 939 404 |
| Cash: | | | | |
| Corporation for Public Deposits | | | 27 107 153,51 ^{6b} | 12 751 715 |
| SA Reserve Bank | | | 480 911,13 | 1 104 095 |
| Other banks | | | 70 465,49 | 100 147 |
| Petty Cash Imprests | | | 76 140,17 | 68 160 |
| Current liabilities | | | 20 570 186,06 | 14 824 076 |
| Advances for investigations and services | | | 9 140 969,34 ⁷ | 8 269 567 |
| Creditors and credit balances | | | 11 429 216,72 | 6 554 509 |
| Total | | | R274 720 665,60 | 223 508 183 |

¹Transfer from operating to equipment fund R4 895 020,13.

²Includes assets for National Institute for Coal Research taken on charge at current value, previously written off in year of purchase R7 504 283,97.

³Includes assets of National Institute for Personnel Research relinquished at disamalgamation R1 775 194,12.

⁴At 31 March 1985 contractual obligations against the General and Building Funds were R23 206 338 and R5 592 433 respectively.

⁵London flat sold.

^{6a} & ^{6b}Research Grants only paid in 1985/86.

⁷Includes Stabilization Funds in respect of Department of Transport (National Road Fund) R347 180,29.

PRETORIA
13 SEPTEMBER 1985

(Sgd.) J D VAN ZYL
Chief Director: Administrative Services

(Sgd.) C F GARBERS
President

The above Balance Sheet has been audited in accordance with the provisions of section 42(4) of the Exchequer and Audit Act, No. 66 of 1975 read with section 16(1) of the Scientific Research Council Act, No. 82 of 1984, and in my opinion it has been drawn up so as to reflect a true and fair view of the financial affairs of the Council for Scientific and Industrial Research.

PRETORIA
24 OCTOBER 1985

(Sgd.) H J VAN ECK
Acting Auditor-General

Financial statements

NOTE 1: CAPITAL INCOME

| | General Fund R | Building Fund R | 1985 R | 1984 R |
|---|-------------------|--------------------|---------------|------------|
| Parliamentary grant | 21 633 000,00 | 8 876 000,00 | 30 509 000,00 | 29 417 000 |
| Donations | 22 733,55 | — | 22 733,55 | — |
| Contributions | 67 699,91 | — | 67 699,91 | 135 703 |
| Interest | — | 4 935 220,74 | 4 935 220,74 | 2 938 372 |
| Sale of assets written off | 446 662,99 | — | 446 662,99 | 119 573 |
| Investigations and services | 3 484 273,51 | — | 3 484 273,51 | 2 364 150 |
| Sale of land and buildings | — | 35 300,00 | 35 300,00 | — |
| Surplus on sale of leasehold property | — | 141 538,26 | 141 538,26 | — |
| | R25 654 369,96 | 13 988 059,00 | 39 642 428,96 | 34 974 798 |

NOTE 2: FIXED ASSETS (AT COST OR VALUATION)

| | Land and Buildings R | Books and Journals R | Furniture and Equipment R | Prefab. Structures R | Laboratory Equipment R | Vehicles R | Stores Stock R | Total R |
|---------------------------------------|-------------------------------|-------------------------------|------------------------------------|----------------------------|------------------------------|---------------|----------------------|----------------|
| <i>Balance brought forward</i> | 81 148 447,47 | 6 291 840,59 | 7 222 275,32 | 49 767,24 | 102 050 196,59 | 3 774 804,90 | 1 226 943,43 | 201 764 275,54 |
| <i>Purchases:</i> | | | | | | | | |
| CSIR | 11 358 989,46 | 1 371 385,10 | 1 418 008,44 | 13 934,20 | 21 572 194,96 | 491 291,85 | — | 36 225 804,01 |
| Grants | — | 1 810,63 | 44 715,58 | — | — | — | — | 46 526,21 |
| <i>Adjustments previous year:</i> | | | | | | | | |
| CSIR | — | — | 17 112,92 | — | — | — | — | 17 112,92 |
| Grants | — | — | — | — | — | — | — | — |
| <i>Received:</i> | | | | | | | | |
| CSIR | 2 801 440,00 | 77 000,00 | 134 895,21 | 180,00 | 4 916 517,66 | — | — | 7 930 032,87 |
| Grants | — | — | — | — | — | — | — | — |
| <i>Stores Increase</i> | | | | | | | | |
| | — | — | — | — | — | — | 78 241,46 | 78 241,46 |
| | 95 308 876,93 | 7 742 036,32 | 8 837 007,47 | 63 881,44 | 128 538 909,21 | 4 266 096,75 | 1 305 184,89 | 246 061 993,01 |
| <i>Less: Reductions</i> | 370 278,61 | 432 434,12 | 516 384,09 | 20,20 | 2 218 834,84 | 128 052,59 | — | 3 666 004,45 |
| <i>Relinquished</i> | 370 278,61 | 430 674,02 | 365 137,45 | 20,20 | 725 580,69 | 47 123,85 | — | 1 938 814,82 |
| <i>Written off:</i> | | | | | | | | |
| CSIR | — | 1 760,00 | 151 246,64 | — | 1 476 141,33 | 80 928,74 | — | 1 710 076,71 |
| Grants | — | — | — | — | — | — | — | — |
| <i>Adjustments previous year:</i> | | | | | | | | |
| CSIR | — | 0,10 | — | — | 17 112,82 | — | — | 17 112,92 |
| Grants | — | — | — | — | — | — | — | — |
| <i>Balance</i> | R94 938 598,32 | 7 309 602,20 | 8 320 623,38 | 63 861,24 | 126 320 074,37 | 4 138 044,16 | 1 305 184,89 | 242 395 988,56 |

Financial statements

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

STATEMENT 2

STATEMENT OF INCOME AND EXPENDITURE FOR THE YEAR ENDED 31 MARCH 1985

| | Grants R | CSIR R | Total R | 1983/84 R |
|---|----------------|----------------|----------------|--------------|
| <i>Income</i> | | | | |
| Parliamentary grant | 10 329 000,00 | 110 711 726,65 | 121 040 726,65 | 102 848 313 |
| Contributions to CSIR projects | 66 117,00 | 1 966 153,04 | 2 032 270,04 | 1 872 669 |
| Coal levies and penalties | — | 2 075 965,63 | 2 075 965,63 | 2 157 744 |
| Investigations and services | — | 54 651 200,24 | 54 651 200,24 | 45 205 125 |
| Publications | 80,04 | 766 620,27 | 766 700,31 | 735 783 |
| Sundry | 39 494,65 | 1 091 796,71 | 1 131 291,36 | 922 454 |
| <i>Total</i> | R10 434 691,69 | 171 263 462,54 | 181 698 154,23 | 153 742 088 |
| <i>Less: Expenditure</i> | | | | |
| Salaries, wages and allowances | 333 797,81 | 119 398 751,44 | 119 732 549,25 | 100 103 881 |
| Consumable stores and services | 29 644,90 | 41 130 151,68 | 41 159 796,58 | 35 585 944 |
| Subsistence and transport | 67 501,91 | 5 102 162,84 | 5 169 664,75 | 4 694 718 |
| General expenses | 6 888,19 | 13 404 207,49 | 13 411 095,68 | 9 762 080 |
| Extraordinary expenses | — | 2 572,44 | 2 572,44 | 31 385 |
| Grants | 8 764 433,59 | 5 955 918,39 | 14 720 351,98 | 10 126 738 |
| Subsidies: Research by industry | — | 1 369 289,00 | 1 369 289,00 | 1 069 517 |
| Levies and depreciation | 187 218,00 | 19 673 230,31 | 19 860 448,31 | 16 176 286 |
| <i>Less: Income internal services</i> | 9 389 484,40 | 206 036 283,59 | 215 425 767,99 | 177 550 549 |
| | 1 122,93 | 37 234 415,28 | 37 235 538,21 | 31 028 917 |
| <i>Income over expenditure</i> | R1 046 330,22 | 2 461 594,23 | 3 507 924,45 | 7 220 456 |

PRETORIA
13 SEPTEMBER 1985

(Sgd.) J D VAN ZYL
Chief Director: Administrative Services

(Sgd.) C F GARBERS
President

Financial statements

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

STATEMENT 3

CSIR BUDGET 1985/86

A. OPERATING EXPENDITURE

| ACTIVITIES | EXPENDITURE | | | | | | FUNDS | |
|--|---------------|------------------------------------|---------------------------------|-------------|-----------------------------|-------------------------|---------------|--|
| | Salaries R | Direct running expenses R | Awards and subsidies R | Total R | Parliamentary grant R | Recoverable Expenditure | | |
| | | | | | | Internal R | External R | |
| CSIR laboratories and departments | 128 313 500 | 70 931 637 | — | 199 245 137 | 116 646 000 | 21 768 538 | 60 830 599 | |
| Grants and subsidies | 2 867 481 | 3 734 004 | 27 547 065 | 34 148 550 | 23 523 000 | 1 612 410 | 9 013 140 | |
| <i>Subtotal</i> | 131 180 981 | 74 665 641 | 27 547 065 | 233 393 687 | 140 169 000 | 23 380 948 | 69 843 739 | |
| <i>Less: Internal Revenue</i> | — | 23 380 948 | — | 23 380 948 | — | 23 380 948 | — | |
| <i>Total</i> | 131 180 981 | 51 284 693 | 27 547 065 | 210 012 739 | 140 169 000 | — | 69 843 739 | |

B. CAPITAL EXPENDITURE

| ACTIVITIES | EXPENDITURE | | | | | | FUNDS | |
|--------------------------------------|-------------------------|---|--|---------------|----------------|-------------|-----------------------------|---------------------------------|
| | Books/ Journals R | Technical equipment and vehicles R | Furniture/ office equipment R | Bicycles R | Buildings R | Total R | Parliamentary grant R | Recoverable expenditure R |
| | | | | | | | | |
| Grants to universities, etc. | 20 000 | 1 872 660 | 5 000 | — | — | 1 897 660 | 1 431 900 | 465 760 |
| <i>Total</i> | 1 733 623 | 30 783 435 | 689 552 | 1 600 | 8 700 000 | 41 908 210 | 37 165 000 | 4 743 210 |
| <i>GRAND TOTALS A & B</i> | | | | | | 251 920 949 | 177 334 000 | 74 586 949 |

CSIR PERIODICAL PUBLICATIONS

Annual report of the CSIR

Gratis.

Scientiae

Quarterly. Feature articles and news items on scientific topics. Gratis.

TI – technical information for industry

Irregular. Short articles on aspects of CSIR research with industrial application. Issued by the Industrial Extension Service, National Institute for Informatics. Gratis.

CSIR publications

Quarterly list of articles and reports published under the auspices of the CSIR, with keyword and author indexes. Also contains information on recent translations by the CSIR Foreign Language Service. Gratis.

The CSIR – organization and activities

Regularly updated. A directory of the various divisions and services of the CSIR. Gratis.

Scientific research organizations in South Africa

Every two years. A guide to government organizations, statutory bodies and industrial concerns which maintain research laboratories. Price varies.

Scientific and technical societies in South Africa

Every two years. A guide to societies, giving particulars of their aims and objects, membership, publications, etc. Price varies.

NBRI information sheet

Every two months. Brief articles on technical and practical problems related to building. Gratis.

Housing research review

Irregular. Newsletter of the Housing Research Information Service, National Building Research Institute. Gratis.

Houtim

Quarterly. Technical news for the timber industry, compiled by the National Timber Research Institute. Gratis.

VIA

Abstracts bulletin published twice a year covering all unrestricted technical reports and other publications of the National Institute for Transport and Road Research issued during the preceding six months. Gratis.

SAWTRI bulletin

Quarterly. Technical news for the textile industry compiled by the South African Wool and Textile Research Institute. Gratis.

Water report

Six-monthly. National Institute for Water Research newsletter. Gratis.

NEERI news

Quarterly. General newsletter of the National Electrical Engineering Research Institute. Gratis.

Transport and road digest

Irregular. Summaries of research projects giving the background and main results. Issued by the National Institute for Transport and Road Research. Gratis.

GTES newsletter

Irregular. Articles and news items on techno-economic topics. Gratis.

NAC news

Irregular. Short reports on the progress of the National Accelerator Centre. Gratis.

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NCRL news

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NPRL newsletter

Annually. Highlights of activities of the NPRL. Issued by the National Physical Research Laboratory. Gratis.

MTR – Manufacturing technology reviews

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