1975

council for scientific and industrial research

thirty-first annual report

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CSIR

Council for Scientific and Industrial Research

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Our ref. Your ref. 1 May 1976

Dr the Hon. S W van der Merwe
Minister of Planning and the
Environment
Private Bag X9068
CAPE TOWN
8000

Sir

I have pleasure in presenting to you the thirty-first Annual Report of the Council for Scientific and Industrial Research. This report covers the period 1st January 1975 to 31st December 1975.

Balance sheets and statements of income and expenditure for the financial year ended 31st March 1975, certified by the Controller and Auditor-General, are included.

Yours faithfully

C vd M Brink
PRESIDENT

members of the council for scientific and industrial research

Dr C v d M Brink - Chairman
President of the CSIR

Prof. A J Brink
President
South African Medical
Research Council

Mr M T de Waal
Joint General Manager
Industrial Development
Corporation of South Africa Ltd

Prof. C A du Toit
Professor of Zoology
University of Stellenbosch
(Until 15 June 1975)

Dr B Gaigher
Member
Board of Trade and Industries

Mr G C V Graham
Managing Director
Veldspun (Pty) Ltd

Dr J N van Niekerk
Head
Basic Research Division
Research Department, ISCOR

Dr A J A Roux
President
Atomic Energy Board

Mr J W Shilling
Former Director
Anglo American Corporation
of South Africa Ltd

Prof. E T Woodburn
Head
Department of Chemical
Engineering, University
of Natal

Dr P S Rautenbach
Chairman
Public Service Commission

Dr L B Knoll
Managing Director
Massey-Ferguson South Africa Ltd

Prof. H P van der Schijff
Dean
Faculty of Science
University of Pretoria
(As from 27 July 1975)

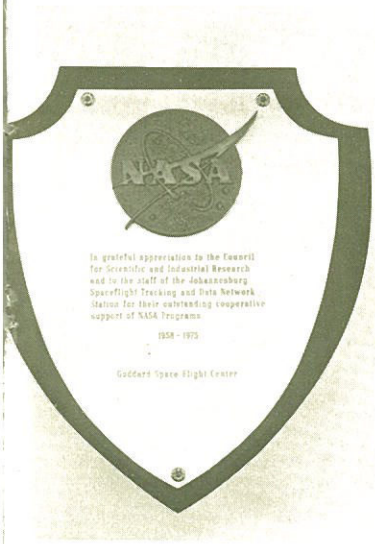
the year in retrospect

Three decades of service

The year 1975 saw the thirtieth anniversary of the CSIR. Established in 1945 as a statutory body to assist South Africa in meeting the challenges of a new technological era, the CSIR has grown from modest beginnings into a large organization whose activities cover virtually every field of science and technology. In the three decades of its existence this organization has made significant contributions in various fields, nationally and internationally. This was emphasized by the Minister of Planning and the Environment in his address at the opening of the new laboratories of the National Institute for Telecommunications Research in Johannesburg.

The work of the National Institute for Telecommunications Research, which was established in 1946, provides a good example of the way in which the CSIR has served the national interest and gained international recognition. The Institute was responsible, amongst other things, for what is perhaps the CSIR's best-known achievement — the 'Tellurometer' system of distance measurement by means of radio waves which revolutionized survey procedures throughout the world and stimulated a local manufacturing industry.

This plaque was presented by the US National Aeronautics and Space Administration in appreciation to the CSIR for its support of the NASA programs from 1958 to 1975.



Another area in which the Institute gained international recognition was in the operation on behalf of the US National Aeronautics and Space Administration of the tracking station at Hartebeesthoek which ceased in October 1975. In this operation, which extended over eighteen years, Hartebeesthoek established a proud record as one of the most efficient stations in the network, and the high standard of efficiency was maintained until the end. Currently the Institute is operating a satellite tracking station at Paardefontein in the Transvaal on behalf of the French Centre National d'Etudes Spatiales (CNES) — a further example of the confidence in the ability of the Institute shown by major overseas agencies.

The new laboratories of the Institute are situated on a hill-top site formerly occupied by the Republic Observatory. At the opening of the new building, the Minister unveiled a plaque commemorating the fact that the site had been dedicated to science for more than seventy years.

National services

It was announced towards the end of the year that the central CSIR Library and related information services will in future operate as a Centre for Scientific and Technical Information with its own identity. This development arises from increasing commitments at the national level, including the provision of computerized information services to scientists and a current awareness service to industry. Operating as a separate entity within the framework of these services is the South African Water Information Centre which is financed by the Water Research Commission and which aims at co-ordinating all information activities concerning water and related topics of interested organizations (including the CSIR).

Research by the CSIR in the field of urban transport is being expanded considerably following recommendations of the Committee of Inquiry into Urban Transport Facilities in the Republic (the Driessen Committee). This work will be undertaken by the Transportation Group of the National Institute for Road Research and will include studies of transport planning, public transport and traffic control.

The National Mechanical Engineering Research Institute has been given full responsibility for the rock mechanics investigations required for the design of two major hydro-electric power schemes in the Republic. This is a significant development, as previously overseas consultants would probably have been commissioned for this type of work. Local expertise is also recognized to an increasing extent in investigations related to the hydraulic transportation of materials such as coal and other minerals in pipelines over long distances, as has become evident from the number of requests for such investigations received by the Fluid Mechanics Division of this Institute.

The CSIR is actively involved in research related to the protection of power lines and electrical installations against damage by lightning. Some 400 lightning flash counters of a type developed by the National Electrical Engineering Research Institute are being installed countrywide for the purpose of producing a map of ground lightning intensities in the Republic. This survey, which is expected to extend over some ten years, will provide valuable quantitative information to designers of transmission lines, communication systems and buildings as to the severity of lightning that can be expected in a given area.

A major investigation into the thermal environmental requirements for human comfort, health and productivity in industrial buildings has been started by the National Building Research Institute in collaboration with various research and industrial organizations and government departments. This work, which is partly sponsored by the Department of Labour, is primarily aimed at providing guidance in the design of factories and the improvement of indoor working conditions.

Research related to the provision of community services, such as the provision of adequate housing, continues to form an important part of the CSIR's activities in the public sector. A new research and development framework for low-cost housing for Blacks in South Africa has been established by the National Building Research Institute in collaboration with the Department of Bantu Administration and Development. This has created opportunities for testing new ideas, concepts and hypotheses by practical application in pilot development projects before implementation on a wider scale.

In South Africa there is a growing interest in the economic aspects of pollution and environmental conservation, and the year saw the completion of an investigation into the litter problem. This investigation was undertaken by the CSIR's Group for Techno-economic Studies on behalf of the Keep South Africa Tidy Group (representing a number of companies) in association with the Department of Planning and the Environment.

Industrial research

The services offered to industry by the CSIR were discussed at a seminar held in Pietermaritzburg in June on the occasion of the meeting of the CSIR Council in that city. Each year the CSIR holds one council meeting in a centre other than Pretoria to give local industrialists and other interested parties an opportunity to become acquainted with its Council Members and senior officials and to form an idea of its activities and facilities. At the seminar in Pietermaritzburg an audio-visual presentation featuring services in the field of automation and production technology was followed by a discussion at which senior staff members answered specific questions and provided more detailed information. Among those that attended the seminar were members of the Natal and Pietermaritzburg Chambers of Industry.

The need for training in the textile industry, one of South Africa's most important secondary industries, was the subject of a national conference held in Johannesburg during June. The South African textile industry is experiencing an acute shortage of trained Coloured, Indian and Black personnel and the conference gave the industry the opportunity of defining its training requirements and working out a plan of action. The establishment of a national training board for this diversified industry was unanimously recommended and a continuation committee has been set up under the chairmanship of the President of the CSIR to carry out this recommendation.

An interesting example of work aimed at the better utilization of natural resources is the development of wattle-based adhesives. The Leather Industries Research Institute has developed a range of adhesives from wattle bark tannins to provide additional outlets for a product of which the supply is in excess of the requirements of the leather industries and to find alternatives to adhesives based on imported materials. The CSIR Timber Research Unit is also developing this type of adhesive to meet the requirements of the local stocklam industry.

The establishment of a microcircuit production facility at the CSIR was announced during 1975. This facility, which will become operational by the middle of 1976, is intended for the manufacture of integrated circuits which are not commercially available in the country, and will make possible the manufacture of integrated circuits for strategic purposes. It will also be available to industry for the manufacture of non-standard circuits and it is hoped that this will encourage South African circuit designers to develop their own proprietary electronics systems for local manufacture. A design course for prospective users was held during the year and some circuits that can be adapted for initial experiments by users were developed. The facility will be operated by the National Electrical Engineering Research Institute.

The necessity for quality control, sophisticated measurement and process control techniques in industry was emphasized at the symposium on precise physical measurement organized in Pretoria during April by the CSIR and the South African Bureau of Standards. On this occasion, too, the services available from the CSIR and its sister organization, the South African Bureau of Standards, to South African industry with its increasing level of sophistication, were set out.

A development of importance to the metal engineering industry was the introduction during 1975 of a Production Engineering Advisory Service, based on the CSIR's Technical Services Department. This co-ordinates various services including the development of prototype equipment, assistance with the machining of complex components, advice on the choice of machines for particular applications and on the optimum use of machine tools as well as intensive training courses in numerical control and low-cost automation. The impact on industry of courses in low-cost automation conducted by the CSIR since 1971, has led to collaboration with the National Productivity Institute in the introduction of low-cost automation in industry which includes the conducting of brief courses at firms nominated by the Institute as well as the operation of a mobile LCA unit which was commissioned during the year.

Basic research

During the current financial year an amount of R1 742 800 was made available by way of grants for the promotion of research at universities and museums. In discharging this important function, the CSIR is advised by a Research Awards Committee on which academic staff of the various institutions serve in rotation.

In addition to its support for university research (where the sole criteria are the abilities and initiatives of the applicants, as adjudged by their peers) the CSIR organizes national programmes of scientific research and observation, often associated with international endeavours, in collaboration with universities and other bodies. The increasing importance of activities in this category has led to the formation of a separate National Scientific Programmes Unit within the CSIR, which is responsible for the development, co-ordination and administration of the programmes under the guidance of national committees.

Some noteworthy achievements by the CSIR's own laboratories in various fields of basic research can also be reported. These arise, for the most part, from fundamental studies undertaken as an essential component of applied research and development programmes orientated towards major fields of application, which are of importance to the national economy and welfare of the community.

Mathematics may rightly be considered the most basic of the natural sciences and constitutes a necessary investment for future applied scientific research. Work in this field has already achieved world-wide recognition for researchers at the National Research Institute for Mathematical Sciences. A particular example of such a project is one which yielded numerical methods for calculating finite-part integrals involving an algebraic singularity, which found application in determining the electric field and its derivatives in electron optics research. Mathematical models have also been constructed for population and birth and death processes which have found application in determining optimum fish harvesting policies.

A comprehensive synthesis-structural study of platinum metal complexes that bind molecular oxygen has clarified the concept of bonding in these model complexes, which has been the subject of controversy among internationally recognized authorities. This study, which was undertaken by the National Chemical Research Laboratory, also involved scientists at other laboratories.

The biosynthesis of the important fungal carcinogens, aflatoxin B_1 and sterigmatocystin, has been elucidated through labelling experiments and the application of a new spectroscopic technique developed at the National Chemical Research Laboratory. Scientists in this laboratory also made an important contribution to the world-wide study of membrane structure and function in finding that snake venom cardiotoxin-mediated red cell hemolysis is not due to the direct action of the toxin on the red cell membrane, but rather to a membrane-bound component, liberated by the toxin.

The CSIR also gained international prestige through the ingenious use by the National Physical Research Laboratory of more than 1 000 km of the Cabora Bassa power transmission line to probe the earth's crust and upper mantle by means of deep electrical sounding to a record depth of about 300 km.

Work by the Laser Group of the National Physical Research Laboratory resulted in a provisional patent covering a technique for high-volume low-pressure glow discharge within a matter of nanoseconds. The successful combination of photo-ionization and corona stabilization resulted in the construction of a laser head which develops large volumes of gas and is much more powerful than existing UV-nitrogen lasers.

The National Physical Research Laboratory is paying considerable attention to the occurrence of hailstorms and the formation of hailstones. It has recently been established that deuterium analysis of hailstones can provide information on their growth course in a cloud. It was even found possible to correlate height and air temperature with the course of the hailstone. This technique, combined with a study of stone transparency, has now been applied for the first time to stones obtained from storms of which the surface patterns and radar structures had also been studied.

Valuable information on the Earth's upper-atmosphere has been obtained through a co-operative effort in which two scientists, invited from the National Institute for Telecommunications Research, are participating in the United States' space research programme. Airglow has been measured by the NASA Atmospheric Explorer satellite and by a ground-based photometer at Sutherland for determining certain parameters relating to the chemistry of the upper-atmosphere in mid-latitudes. In another experiment the satellite-borne photometer is calibrated by means of ground-based photometric data from a number of stations including Sutherland.

The National Institute for Telecommunications Research has made a number of interesting and often surprising observations on lightning discharges. It has been found that lightning flashes can be categorized according to the spatial pattern of precipitation to which the flash tracks are related. The line density of charge has been found to be the same for all lightning channels, to within ten per cent. The speed of flashes, however, vary between 100 000 and 200 000 m/s, except in the case of discharges along existing channels.

The South African Astronomical Observatory has concluded work on the radial velocities and photoelectric light curves of about twenty Cepheid variable stars in the galaxy and the results are in an advanced stage of preparation for publication. These curves are some of the most accurate so far obtained anywhere. A joint programme with observers in the United Kingdom on the study of stars near X-ray sources has been published and a number of other investigations of X-ray sources (chiefly ultraviolet, blue and visible photoelectric photometry, some in collaboration with NASA X-ray observations from satellites) have been continued.

International co-operation

A noteworthy development in the sphere of international co-operation was the establishment by the CSIR of a scientific liaison office in Tehran. Like the offices maintained by the CSIR in Washington, London, Paris and Bonn, this office will have the task of promoting two-way exchange of scientific and technical information and facilitating personal contact between South African scientists and engineers and their colleagues abroad. The Office is attached to the South African Consulate-General in Tehran, where the head, Mr Glen Harvey, holds the position of Consul (Scientific).

The extension of contact with Iran in the scientific and technological sphere has led, *inter alia,* to a visit by Dr K Asayesh, Director-General of Health and Medical Affairs in the Iranian Ministry of Roads and Transportation, who also visited several other scientific institutions while in South Africa.

Other prominent overseas visitors in 1975 included Dr LBJ Stuyt, President of the Organisatie voor Natuurwetenschappelijk Onderzoek — TNO in the Netherlands (and a former Minister of Health in the Netherlands); Prof C de Jager, President of COSPAR and member of the Executive Committee of the International Astronomical Union; and Lord Zuckerman of Burnham Thorpe, the distinguished South African born scientist who recently retired as Chief Scientific Adviser to the British government.

CSIR scientists continue to take an active part in scientific meetings abroad. At the end of November seven South African scientists led by the Director of the CSIR's National Institute for Water Research attended a symposium in Jerusalem on the recycling of waste water for agricultural and industrial use at the invitation of the Israeli National Council for Research and Development. This symposium resulted from a visit to Israel by the President of the CSIR and the Secretary for Agricultural Technical Services during March to promote the exchange of scientific and technical information between the two countries.

The CSIR also played a prominent role at an international conference on water supply and pollution control which was held in Mbabane, Swaziland, during June. The conference was sponsored by the local co-ordinating committee of the International Association on Water Pollution Research and the International Water Supply Association and the purpose was to provide an opportunity for exchange of information on the provision of adequate water supplies of acceptable quality and the effective control of water pollution in the developing parts of Southern Africa.

The historic meeting of the Conférence Générale des Poids et Mesures held in Paris during 1975 to mark the centenary of the signing of the Metre Convention, was attended by delegates of the CSIR who are also active in the International Metrological Committee.

South Africa is also making its contribution in the field of computer application and automation. It was announced during the year that the Director of the CSIR's National Electrical Engineering Research Institute had been elected chairman of the Technical Committee on Computers of the International Federation of Automatic Control. This Committee, with membership drawn from 27 countries, will be responsible for sponsoring various symposia during the next three years.

A noteworthy international event in the field of oceanology was the meeting of the Executive Committee of the Scientific Committee for Oceanic Research (SCOR) which was held at the University of Stellenbosch during November and hosted by the CSIR. One of the important developments at this meeting was the acceptance of the South African proposal for an international workshop on western boundary currents of the Indian Ocean, which will probably be held in Durban during 1977.

As a pilot study to an international oceanographic study which will be undertaken in collaboration with the USA, the National Research Institute for Oceanology of the CSIR launched a number of satellite-tracked drift buoys during August and September.

Collaboration with NASA in the use of LANDSAT 1 (formerly known as the Earth Resources Technology Satellite — ERTS — and launched in 1972) produced data of value to South African geologists, land surveyors, regional planners and agricultural specialists. Some of the images of South Africa returned by this satellite were collated by the CSIR's National Physical Research Laboratory and published in 1975 in the form of an atlas. It is expected that LANDSAT 2 which was launched early in 1975 will also produce data of considerable value to South Africa.

Appointments

Prof HP van der Schijff, Dean of the Faculty of Science at the University of Pretoria, was appointed to the Council for a period of three years from July 1975. Prof Van der Schijff, a distinguished botanist and the author of

Executive of the CSIR
Left to right:
Dr FJ Hewitt (Deputy President)
Dr A P Burger (Vice-President)
Dr P J Rigden (Vice-President)
Dr J F Kemp (Vice-President)
Dr C v d M Brink (President)

numerous scientific publications, is also a council member of the University of Pretoria and a member of several national and international professional organizations.

Dr B Gaigher, for 21 years a CSIR Council member, resigned during the year upon his retirement from the Chairmanship of the Board of Commerce and Industries. He will be replaced by Mr DP de Villiers, General Manager of Sasol, well-known nationally and internationally as an industrial leader in the oil from coal industry, as Chairman of Soekor in the search for natural oil sources and as key figure in the Sasol II development.

Also announced during the year was the reappointment for further three-year terms of Mr MT de Waal, Joint General Manager of the Industrial Development Corporation, Dr AJA Roux, President of the Atomic Energy Board and Prof ET Woodburn, Dean of the Faculty of Engineering at the University of Natal.

The CSIR suffered a severe loss in June 1975 in the death of its Secretary/Treasurer, Mr JH Visagie, who had held the position since January 1964. Mr Visagie had been associated with the administration of scientific activities for more than 25 years. His successor is Mr JD van Zyl who was appointed to the newly designated post of Secretary in October 1975. At the same time Mr JH van As was appointed to the post of Deputy Secretary and Financial Manager.

NCRL

chemical research

NATIONAL CHEMICAL RESEARCH LABORATORY

Director - DR P R ENSLIN

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

In accordance with a policy of concentrating on research in fields where a need for more basic knowledge exists, many of its research projects are carried out in collaboration with research organizations that are more directly concerned with the practical problems involved. Well-motivated long-term projects are, therefore, approached from a fundamental point of view.

The NCRL is organized into divisions of analytical chemistry, biological chemistry, inorganic chemistry, organic chemistry, molecular biochemistry, physical chemistry and corrosion research. The physical chemistry division is also part of a chemical physics group which operates in conjunction with two divisions of the National Physical Research Laboratory.

Pharmacologically active substances

The carbohydrate moiety of the antibiotic lincomycin has been synthesized through application of a new method, commencing with an appropriate nitro-epoxide. Progress has also been made toward the synthesis of lincomycin analogues containing nitrogen in the carbohydrate ring, and/or those in which the stereochemistry at C(4) differs from that of the naturally-occurring antibiotic.

In a continuing programme to delineate structure-activity relationships in the 9β-methyl-19-nor-retrosteroids, the 17α-acetoxy-derivative of the progesterone analogue has been synthesized. Further progress has also been made toward rationalising unusual features of reactivity in the A- and B-rings of this series.

A new method has been developed for the synthesis of steroidal β-hydroxy-lactones through intramolecular condensation of appropriate α-acyloxy-ketones. It has also been demonstrated that the scope of the reaction can be extended to more remote interacting groups, leading to δ-lactones or the formal 1,3-transposition of the ester moiety.

Metabolites of poisonous fungi

The biosynthesis of two carcinogenic metabolites, aflatoxin B_1 and sterigmatocystin, was investigated through feeding experiments using singly and doubly labelled ^{13}C-acetate. Specifically ^{13}C-enriched carbon atoms and intact acetate units in the products were determined through carbon-13 NMR spectroscopy. Complete biosynthetic schemes were formulated, and it was established that the metabolites originated from a common anthraquinone precursor, such as averufin.

The structure and stereochemistry of a number of new metabolites were studied.

Membrane-active proteins

A molecular bilayer, consisting of phospholipids with their hydrocarbon tails towards the inside of this bilayer, forming a fluid environment for other functionally active proteins both loosely and strongly associated with the lipid constituents, forms the generally accepted picture of a biological membrane. It is the specific interaction of the membrane-active components of snake venoms with one or more of these membrane constituents that is being actively pursued at the present. Lysis of red blood cells by these compounds, it now appears, is not only a mechanism of destruction, but rather by activation of a membrane component of the red cell which in itself causes lysis.

Considerable progress has been made on the elucidation of the mechanism of action of phospholipase A, another venom component acting on the cell membrane. Spectral studies indicated a tryptophan residue in the structure of the enzyme to be associated with the productive binding of phospholipase A with its substrate.

Biochemistry and physiology of ticks

The control of ticks is becoming increasingly difficult as they develop more resistance to conventional pesticides. The Biological Chemistry Division has joined forces with the Entomology Division of the Veterinary Research Institute at Onderstepoort in a study of the biochemistry and physiology of ticks with a view to developing alternative control methods.

Tick endocrinology is receiving particular attention because of the success of similar studies in insects. Work overseas has shown that a juvenile hormone is vital to control the development of the

insect from the juvenile or larval stage to the adult. Synthetic compounds mimicking the action of juvenile hormone have been successfully used in the control of insect pests such as mosquitoes and stable flies. Nothing, however, is known of the role of hormones in controlling the life cycle of ticks, and work has been started by the Division to follow the pattern of neurosecretory action during development of the sand tampan. At the same time trials to determine the effect of commercially available insect juvenile hormone mimics on ticks are being carried out.

Surface chemistry

In some technologically important areas of research, for instance catalysis, lubrication and wear, and corrosion, the nature and structure of the first few atomic layers of the sample are of critical importance. Photoelectron spectroscopy is an ideal method for studying the composition of solid surfaces on the atomic level, as the sampling depth is only about 50 Å (10 atomic layers).

A valuable contribution has been made at the NCRL to the understanding of the surface composition of galena, a lead sulphide mineral. A photoelectron study has shown that the surface is actually composed of a layer of lead oxide, which covers the lead sulphide to a depth of about 20 Å. The presence of the oxide has important consequences for the extractive chemistry of galena as the successful recovery of the ore depends upon the interaction of certain chemicals (flotation agents) with the ore surface.

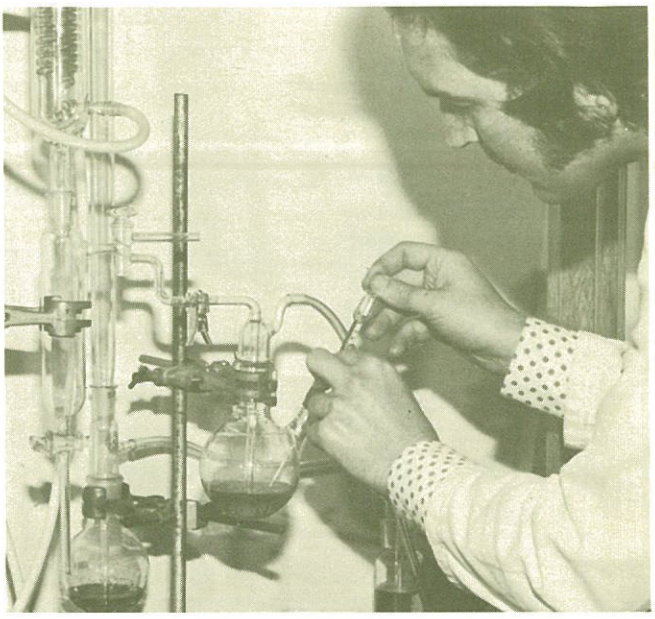
Carbon-13 nuclear magnetic resonance spectroscopy

Carbon-13 NMR spectroscopy has been used for some time at the NCRL in organic structural analysis, biosynthetic studies and industrial applications. For instance the biogenetic pathway of aflatoxin B_1, a highly carcinogenic compound occasionally contaminating peanuts and other foodstuffs, could elegantly be elucidated with carbon-13 NMR spectroscopy. The characteristics of carbon-13 spectra permit the investigation of complex mixtures of organic compounds, and possible applications to waxes and road tars are being explored.

A Varian CFT-20 NMR spectrometer has recently been installed at the NCRL. The instrument is capable of recording NMR spectra of the carbon-13 isotope present in all organic compounds in 1 per cent natural abundance on a routine basis. A carbon-13 spectrum service has been offered to universities, research institutions and industrial laboratories. Carbon-13 NMR spectroscopy as a routine analytical technique has thus become available for the first time to scientists in South Africa.

Corrosion of galvanized pipes

A project concerned with corrosion of galvanized hot water pipes has progressed to the stage where a final report is being prepared. One further aspect now being investigated, in collaboration with the pipe manufacturers, is the effect of a variation in purity of the zinc ingot used in the galvanizing process. It has been established from the literature that small amounts of magnesium, aluminium, copper, tin and titanium present as impurities in galvanized coatings can have a significant effect on its corrosion resistant properties.



Ketene being generated for use in acetylating steroid intermediates.

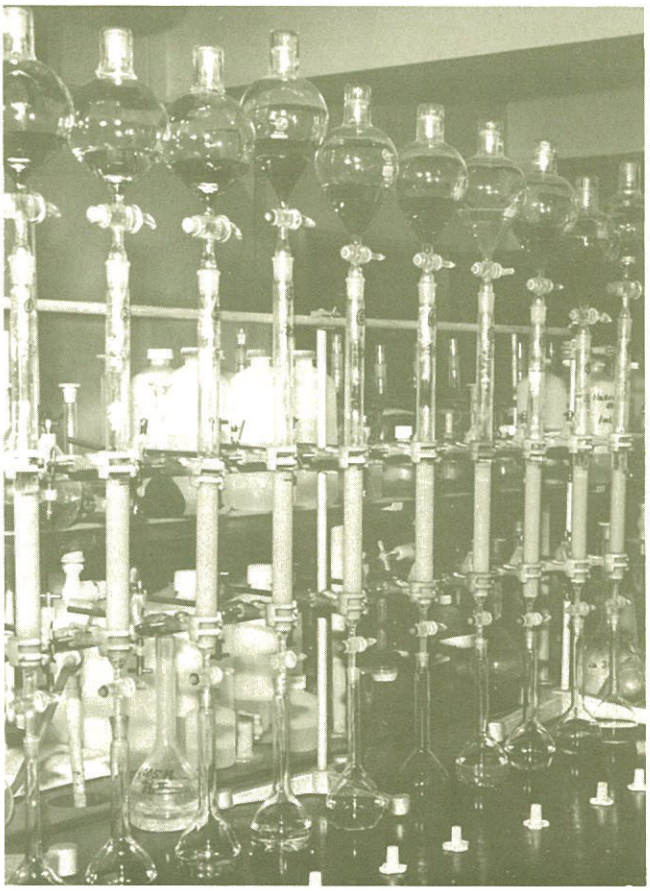
Since 1968 high purity electrolytic zinc (99,95 per cent zinc) was introduced in this country in the manufacture of galvanized pipe and replaced the previously used refined zinc obtained from Rhokana or Broken Hill with a purity of 98,50 per cent zinc which was then claimed to be the purest refined zinc in the world. As compared with imported pipes it is possible that the locally produced galvanizing (since 1932) was relatively free from minor metallic impurities which would have rendered it more durable.

The minor constituents in galvanized coatings on pipes manufactured since the turn of the last century both from overseas and local sources are being investigated. In this way it is hoped to establish which minor impurity formerly present in sufficient amounts to effect the corrosion behaviour beneficially is today absent in the galvanized coatings. Since electrolytic zinc is extensively used this could explain the loss in corrosion resistance of galvanized pipe throughout the world.

Analytical chemistry

Very selective methods for the separation of lithium, lead and indium from a large number of other elements have been developed. Trace amounts of lithium in the six South African NIM rock standards could be determined very accurately by atomic absorption spectrometry, after total separation from other elements by ion exchange chromatography. This approach is very useful for the accurate determination of trace elements in standard rocks and minerals, and will be applied to the determination of other elements.

This dedicated carbon-13 NMR spectrometer has recently been installed at the NCRL to provide service to universities, research organizations and industry.



Ion-exchange columns used in multi-element separations prior to instrumental analysis.

It has been shown that by using acetone containing eluting agents the partial retainment of gold on a cation exchange column can be suppressed very effectively. Thus a much better analytical separation from base metals can be obtained. By using a radioactive gold tracer produced from a platinum target by deuteron bombardment in the cyclotron of the National Physical Research Laboratory, it was demonstrated that even for very small amounts of gold (about 500 nanograms), 99,9 per cent of the gold could be recovered in a separation from several 100 milligram amounts of base metals.

Platinum metal compounds

The synthesis of new ruthenium complexes has progressed considerably and the research programme has received support from the Chamber of Mines. Ruthenium is capable of forming complexes that conform to most of the prerequisites for potential catalytic activity. These compounds are synthesized and identified in the laboratory using all available physical techniques that are at our disposal within the CSIR. The compounds undergo a variety of reactions, e.g. insertions, reduction of unsaturated molecules, oxidation of olefins, coupling reactions and decarbonylations.

The behaviour of iridium(I) complexes in solution is being investigated analogous to that of rhodium(I) in the course of establishing mechanistic detail for the reactions of all of the platinum metals. Much of this work lays the foundation for studying the behaviour of the organometallic complexes part of the programme.

Studies on the reactions of carbonyl-metal complexes are continuing, with a change in direction towards reduction of the molecule followed by insertion in order to polymerise carbon monoxide. This programme is of direct interest to SASOL in finding new routes for the utilization of the synthesis gases, carbon monoxide and hydrogen.

NPRL

physical research

NATIONAL PHYSICAL RESEARCH LABORATORY

Director - DR A STRASHEIM

The main function of the National Physical Research Laboratory (NPRL) is to contribute to the development of physical science in South Africa through research aimed at the adaptation of existing knowledge and at the discovery of new facts of value in the solution of technological and industrial problems of national importance. In addition, the NPRL has statutory responsibilities for maintaining national measuring standards of mass, length, electricity, radiation, etc.

The successful practice of the science of physics requires proficiency in highly advanced techniques. The personnel of the NPRL have to become fully conversant with these techniques in order to contribute to the solution of industrial and national problems as far as physical measurements and methods are concerned. The development of new techniques gives rise to, amongst other things, the generation of significant new knowledge at the NPRL. This knowledge enables the NRPL to make a vital contribution towards the solution of problems which are referred to the Institute by industry or the State.

As a result of the enormous scope and variety of the Laboratory's activities, it is practically impossible to review them all annually and therefore this year attention is mainly paid to services. The expert services now being rendered by the NPRL to interested parties in the country, as set out in the paragraphs below, would not have been possible without the establishment of mutual confidence over a long period between industry, statutory and state organizations, the universities and the NPRL.

Application of geophysical methods

The Geophysics Division is a good example of a group which initially only used, tried and tested geophysical methods to determine the physical properties of subterranean layers. The experience gained in this way led to the development of improved apparatus, as well as to the extension and refinement of the interpretation of geophysical results. It enabled the Division to determine the electrical properties of the earth's crust and upper mantle by means of ultra deep electrical soundings. A case in point is the Cabora Bassa project, where a depth of about 280 km was probed.

Similar methods and know-how are also applied in matters of a more practical nature, for example, in the investigation of possible pollution of the Mzingazi lake at Richards Bay and the determination of the groundwater potential in Hereroland.

Collection of crystallographic data

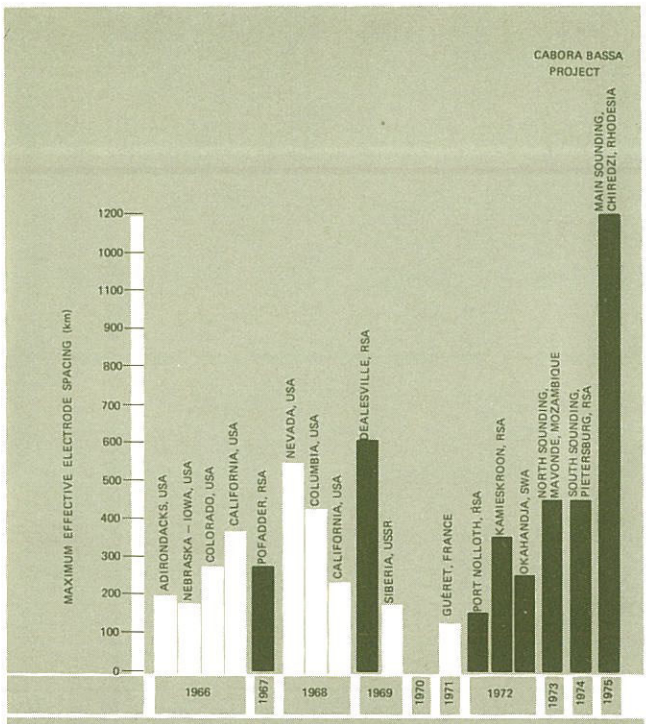
More than 50 crystal structures are now determined annually based on data collected by the Laboratory's automatic single crystal diffractometer. This exceeds the total number of structures determined here before the acquisition of the automatic diffractometer. Universities have been the chief users of this service since its introduction in October 1972.

Scanning electron microscopy

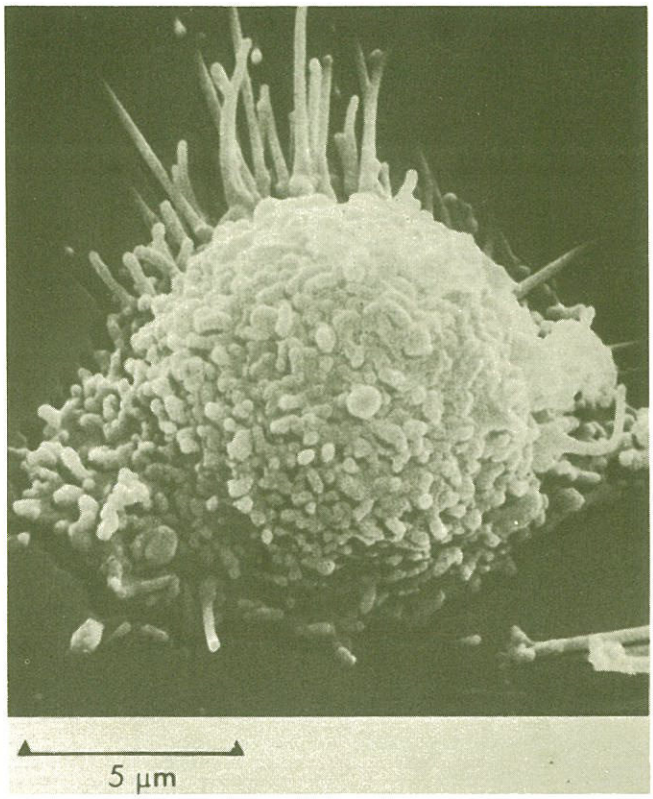
The scanning electron microscopy service was introduced in June 1972 and has been operating on an almost full-time basis from the start. The microscope is being used for an average of 6,5 hours per working day by a variety of users. However, industry and state organizations use it to a much lesser extent than was expected, considering the facilities the instrument has to offer.

Spectroscopic services

The Applied Spectroscopy Division is doing an increasing amount of work for industry, mainly in connection with the development of more rapid and precise methods of analysis using emission spectroscopy. The Division is at present engaged in developing techniques for one overseas firm and two local firms for the analysis of the platinum group metals for major, minor and trace elements by emission spectroscopy using the glow discharge lamp.



The diagram shows the world's most important deep electrical soundings carried out to date. The maximum effective electrode spacings, which are given in kilometers, are an indication of the depth penetration attained with each sounding. Although depth penetration is largely dependent on the electrical conductivity of the near-surface rocks it can, as a first approximation, be taken as one quarter of the maximum electrode spacing.



A scanning electron micrograph of a pulmonary alveolar macrophage from a normal rat. (Work done for the National Research Institute for Occupational Diseases of the South African Medical Research Council.)

In addition, the Division assists with the testing of spectrometers, for example the equipment recently acquired by a refinery for the analysis of gold, and gives advice in connection with the purchase of new analytical instruments.

Measurement standards

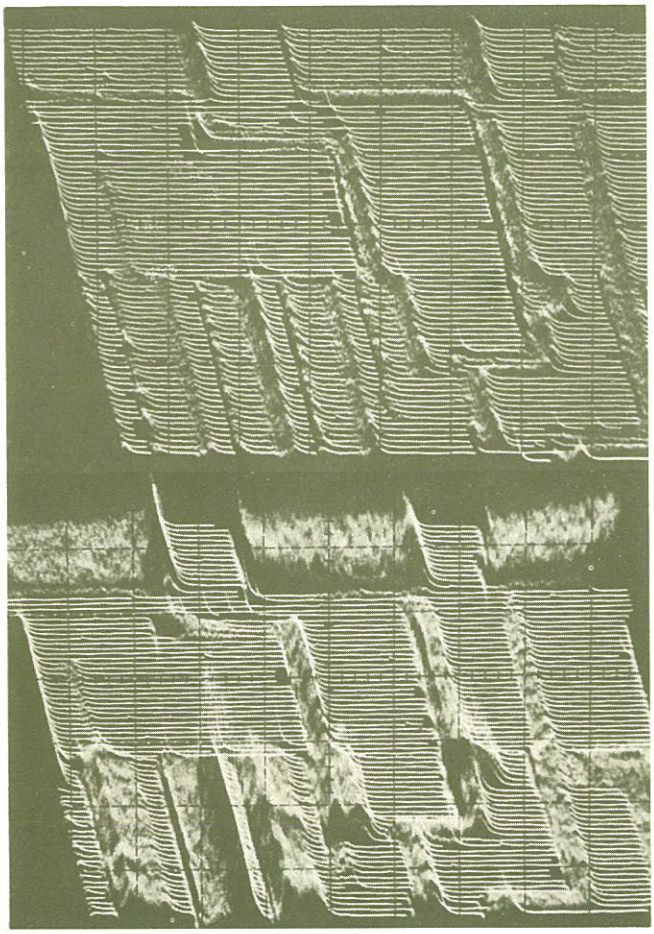
Apart from the establishment and maintenance of primary standards for South Africa, the rendering of calibration services is another important function of the Precise Physical Measurements Division. The calibration services are done in such a way as to facilitate the traceability of accuracy to the national standards. A particular example is the calibration of gauge blocks — the length standards of the engineering industry. The NPRL now co-operates closely with the standards rooms and quality control departments of several industries regarding the measurement of mass, length, time, temperature, electricity and light.

South Africa's national celebration of the Metre Centenary was organized by the NPRL and the South African Bureau of Standards. Emphasis was laid on educating the country to the proper approach to measurement accuracy, quality control and metrication. Besides various publicity projects via schools and the radio a symposium on Precise Measurement in Physics and Industry was held. It was attended by over 200 delegates and served, among other things, to promote contact between scientists and industrialists.

The NPRL sent delegates to the centenary meeting of the Conférence Générale des Poids et Mesures (CGPM) in Paris and every effort was made to determine trends and opinions in metrology and to make contact with overseas experts. The Laboratory's active association with the CGPM's international committees in the fields of electricity, ionising radiation, photometry and radiometry allows it to keep abreast of developments and to have a voice in affairs on an international level.

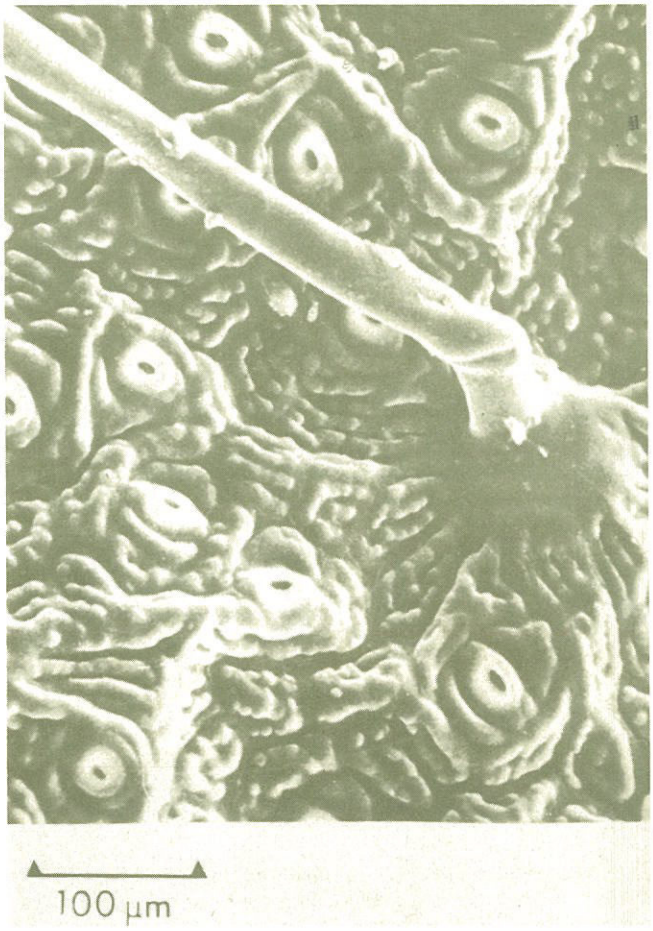
Production of medical isotopes

During the year fourteen different carrier-free radioactive isotope species were produced with the CSIR cyclotron for medical and industrial use in the country as well as for export.
193 consignments with a total activity of 4 300 mCi worth R17 000 were sent to seven hospitals in all four provinces with facilities for radioactive diagnosis. Overseas distributors received 22 bulk consignments worth R56 000 of 2 500 mCi of relatively long-lived activity. Most of the isotopes used in the country would have been unobtainable were they not locally produced.



Demonstration of the use of the ion microprobe mass analyser (IMMA) in the analysis of an integrated circuit showing its main advantages, viz. analysis of light elements, even hydrogen, and imaging in any element with high spatial resolution in a three-dimensional mode.

Image of the surface showing the positions of hydrogen *(top)* and aluminium *(bottom)*.
Scale: 1 division = 30 μm..



A scanning electron micrograph of the leaf surface of the rare marsh rose protea *(Orothamnus zeyheri)*. (Work done for the Department of Nature Conservation, Cape Provincial Administration.)

Mass-spectrometric analysis

The spark source mass spectrometer is capable of determining concentration levels of about 0,001 parts per million of elements and isotopes. The instrument serves other divisions within the CSIR as well as other statutory organizations, industry and state departments.

An ion microprobe mass analyser (IMMA) has been acquired recently. This instrument can perform mass analyses on microvolumes of a sample and will be of great value in surface studies — catalysis and corrosion, for example.

Radiometric age determination of rocks

Since 1972 the number of age determinations performed for universities and the Geological Survey has tripled, in spite of the fact that the personnel concerned has not increased. This is ascribed to improved techniques and apparatus.

Hydrological services

Geophysical research concerning the exploitation of groundwater has been done on a contract basis. Natural isotopes were put to good use in hydrological problems, for example to measure the infiltration of rainwater and to determine the age of groundwater.

High-pressure research

The High-pressure Physics Division has the facilities and background knowledge to make significant contributions to research in other fields conducted by a variety of local and overseas laboratories. The demand for such collaboration has steadily increased and has led to a fruitful investigation, carried out with the Department of Chemistry of the University of South Africa, about the vibrational spectra of fluorides. Research leading to publications has been carried out at the request of the Applied Chemistry Division of the Australian CSIRO and of researchers at Philips Gloeilampenfabrieken, Eindhoven, in the Netherlands.

NRIMS

NATIONAL RESEARCH INSTITUTE FOR MATHEMATICAL SCIENCES

Director - PROF D H JACOBSON

mathematical sciences

The National Research Institute for Mathematical Sciences (NRIMS) consists of the divisions of mathematics, computer science, operations research and statistics, and a computing centre. Research activities cover the various branches of mathematics and their applications. Typical fields of study are differential equations, statistical decision techniques and design of experiments, numerical computation and data handling on digital computers.

Functions and structure of Computing Centre

Although from the point of view of administration and organization the Computing Centre is a part of the Institute, it has the mandate to provide the computing requirements of the whole CSIR. Its responsibilities and obligations are, in fact, wider than this, as it should take the lead in scientific computation in the country and acts as a national source of information and expertise covering all aspects of this field. Impetus has been given to these aims by the recent authorization by the CSIR Executive of considerable expansion of the computing power of the Centre, more details of which are given below.

From the beginning of 1975 the Computing Centre staff has been subdivided into three groups: a systems support group, a user support group and an operations group.

The first of these groups is concerned with the maintenance and extension of the operating system of the computer. The user support group liaises direct with the users; its work includes consultative and advanced programming assistance, the maintenance of an information service, the maintenance and extension of a program library, and training in advanced programming techniques. The operations group sees to the running of the computer, schedules the work and manages the punching service, stores, and so on.

Computer hardware

The demand for computing services in the CSIR is continually increasing. During January 1975 the central processing unit (CPU) of the IBM 360/65 was replaced by an IBM 370/158. It was found that the throughput of this system was about 30 per cent greater than that of the IBM 360/65, but in spite of this improvement the new CPU was only temporarily capable of coping with the computing demands. The Computing Centre is thus forced to increase its computing power still further. Approval has been granted for a three-fold increase in computer throughput, which will become operative towards the beginning of the second quarter of 1976.

The existing IBM 370/158 system will be retained and a powerful Control Data CYBER 174 with a double CPU installed additionally. The former system will be used exclusively for information processing, administrative applications and creation of data bases, as well as certain applications for which a dedicated computer is necessary, while the latter computer is intended for scientific and engineering applications and time sharing.

Ordinary differential equations

A good deal of effort was devoted to ordinary differential equations, much of it being concentrated on theoretical aspects — in particular investigations into the stability properties of certain systems of such equations which occur as population dynamic models.

Research workers in other Institutes were assisted with two investigations which involved differential equations, one problem being related to the analysis of the performance of an electric car and the other concerned with the speed of concurrent chemical reactions.

Work was done also on the formulation of birth-and-death processes as dynamic models of interacting populations. Control parameters were built into these models to facilitate their use in control studies.

Partial differential equations

Partial differential equations were involved in the task of separating two almost identical chemical solutions by diffusing them through multiple layers in a cascade arrangement. This problem had been solved previously for the case of a cylindrical geometry; the planar case has now been thoroughly analyzed, and solutions in closed form have been obtained.

Numerical integration

Certain extrapolation methods have been in disrepute in the literature owing to alleged severe numerical instability. A theoretical study of the growth of rounding errors led to analytical bounds demonstrating that these methods are better than had been supposed.

A major advance was achieved in error estimates when quadrature formulas for finite-part integrals are employed. The agreement with the actually observed error was very good. In addition, the concept of 'principal value' integral was examined critically from the point of view of finite-part integration, and a whole class of singular integrals can now be easily evaluated numerically with the formulas previously found.

Integral equations

Fredholm integral equations of the first kind were an area of both pure and applied research. Two practical problems posed considerable numerical difficulties which were overcome only by thorough theoretical investigations.

The first problem concerned the processing of electrical soundings, a practical measuring technique in geophysics. The other problem was related to the design of an electro-optical system to meet specific requirements. In solving this problem, analytical derivatives of the kernel of a certain integral equation were found, with considerable effort. One off-shoot of this work was the implementation of a very powerful program to accelerate the convergence of numerical series; another was a conjugate gradient system solver for rectangular matrices. Both results have already proved to be very useful in other applications.

Optimization and optimal control theory

A new study was started in control theory, with some emphasis on systems with delay. Stabilizability and optimal control of non-linear systems were also considered. It is planned to expand research on optimal control theory.

Interdisciplinary projects

Two interdisciplinary projects were related to aerodynamics and involved both the National Institute for Defence Research and the National Mechanical Engineering Research Institute. The first phase of the first project has been successfully completed.

Other work included a comprehensive sensitivity analysis for the Nylsvley ecosystem project; a first assessment of a possible major research project on a continuum mechanics approach to rock stability, for the Chamber of Mines; and a new series of heat dispersion runs to take into account further data collected at Saldanha.

Technical development and maintenance of programs

A substantial amount of time was devoted to the technical development and maintenance of a number of programs — mostly of considerable size — for other Institutes and external organizations. Typically, such programs had been obtained from elsewhere and lacked adequate documentation and support.

A light pen is used to make alterations on the light screen of the CSIR's IBM 370/158 computer. As the demand for computing services in the CSIR is continually increasing the Computing Centre will have to increase its computing power still further.

Planning problems

Following the successful application of a preliminary town planning model, this work was continued with a view to the construction of a more comprehensive model. Although at the present time there are few quantitative data available, such a model was developed and preliminary results were used to identify the need for further data necessary to establish the model in its final form.

After discussions with members of the Department of Planning and the Environment, and the Economic Advisory Council, the possible application of mathematical models to physical planning problems was studied, particularly to problems arising during implementation of the National Development Plan.

Finally, mention can be made of a contract which has been entered into with a consortium of consulting engineers involved in highway planning for the Transvaal Provincial Administration. The assistance given to the engineers will, in the early stages, be largely based upon programs obtained from the USA.

System simulation

During recent years considerable attention had been devoted to the use of systems simulation techniques as an aid in the analysis of socio-economic trends. While simulation models have been rapidly increasing in complexity, there has been little systematic study of the sensitivity of the approach to faulty data and erroneous assumptions.

Such a study has been undertaken by a member of staff in collaboration with a member of the Applied Mathematics Department of the University of Pretoria. Their results indicate that simulation models are indeed extremely sensitive to small perturbations in certain parameters and relationships.

Decision theory

Theoretical investigation had previously begun into the application of Bayesian decision theory to the formulation of optimal experimental design criteria in the problem of locating a response surface maximum. This work has been continued and is nearing completion.

It is envisaged that during the coming year consideration will be given to the application of decision theory to problems of search and detection.

Computer graphics

Activity in this field was concerned with the development of programs for fitting curves to experimental data. Experience has shown that graphical processing, using existing equipment linked to the central computing system of the CSIR, involves heavy expenditure. The use of a minicomputer with modern display equipment would possibly provide an alternative for the advanced user, while for simpler applications it might be more economical to use simpler and less costly equipment linked to the central system.

Numerical control

An important piece of work done under contract led to extensions of the existing photogrammetric and surface fitting programs. A number of small programs enabled the user to add data to parts of the digitized photogrammetric model. It is possible to make these additions with the aid of interactive graphic programs.

Processing of remotely-sensed data

A study of existing cluster analysis algorithms for classifying ERTS data has been completed. It has, however, become evident that all existing methods suffer from serious drawbacks.

A general program has been made available for selecting and printing ERTS data. Present users of the program include the National Institute for Water Research and the University of Lesotho. As one of the scanners is showing up a constant error, a technique has been developed with which the ERTS picture can be improved.

Data banks

The investigation into data structures suitable for storing geographical indexed data was continued. Data are at present being gathered from the Witwatersrand Electrolytical Committee with a view to testing an algorithm under real conditions. Alternative methods are being sought and will be tested by comparative runs.

As a result of co-operation with the Department of Planning and the Environment, a second and larger source of test data will become available; at the same time a system suitable for that government department will be developed.

Control system for minicomputer

During the development of a large simulation system it turned out to be necessary also to develop a control system for a minicomputer. It is interesting to note that it was more economical to develop the operating system than to adapt existing systems to the project. In the first place cheaper peripheral equipment could be used, and secondly the discipline of modern programming techniques limited the time necessary for development. It is estimated that the same amount of time would have been necessary to make a study of existing systems and alter these.

Estimable functions and testable hypotheses

In view of the importance of the theory of estimable functions and testable hypotheses for practical applications, a study of growth curves was begun. To arrive at the theory the literature was first consulted. In the analysis of variance it is important to know for which linear functions of the parameters an estimator can be found which is invariant for any solution of the system of normal equations. Both univariate and multivariate linear models were studied, and a new project formulated which incorporates this work.

Distribution of income

A function indicating the distribution of income among certain groups of the population of South Africa would be of considerable interest. With this object in view an attempt was made to fit certain functions mentioned in the literature to a given set of data, and although quite some difficulties had to be overcome in estimating the parameters, results were obtained and a report is being prepared.

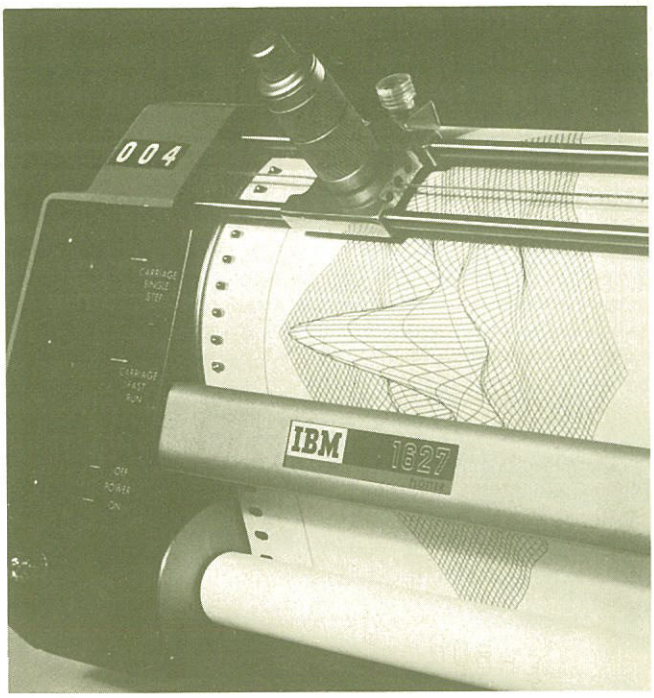
Statistical analysis of palaeontological data

A total of six sites were excavated at Sterkfontein, Transvaal, and for each site the observed number of fossilized bones of each of 33 different species of antelope was recorded by a research worker of the Transvaal Museum. It had to be determined whether these data could be utilized in placing the sites in chronological order.

In the statistical analyses it was assumed that there was an underlying one-dimensional space within which the sites could be ordered. Palaeontologists would usually interpret this dimension as time. It was of course possible that this space might be of higher dimensionality, and in order to provide for such a contingency, multidimensional scaling was considered. This provides techniques by means of which the dimensionality of the space as well as the corresponding configuration of the points may be deduced. An application of this theory to the above-mentioned set of data indicated a dimensionality of two. When the configuration of sites had been plotted in this two-dimensional space and all pairwise distances had been computed, it was found that the relationship between the sites was the same as that which the seriation analyses had yielded.

Analysis of data on blood alcohol content

With a view to simplifying enforcement of the laws against drunken driving, six alcohol breath-testing devices were investigated in collaboration with the National Institute for Road Research, for their ability to reflect a driver's blood alcohol content (BAC) accurately. Regression analyses of BACs and breath test results showed that three of the devices could possibly be used for evidential breath tests and a fourth could provide a reliable screening test.



A three-dimensional sketch being drawn by means of a plotting device used in conjunction with the IBM 370/158 computer in the Computing Centre.

SAAO

SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

Director - SIR RICHARD VAN DER RIET WOOLLEY

astronomy

The South African Astronomical Observatory (SAAO), which is operated by the CSIR in co-operation with the Science Research Council of Great Britain, has been established to conduct astrophysical research. The headquarters of the SAAO have been established in the grounds of the former Royal Observatory in Cape Town. The site for the observing station at Sutherland in the Karoo, at an elevation of 1 760 m, was selected on account of the favourable night sky for astronomical purposes, that is, for the number of fine nights per year, freedom from urban atmospheric pollution, absence of wind and freedom from atmospheric disturbances (the astronomers' 'bad seeing').

The majority of the research programmes undertaken by the Observatory involve massive amounts of observing and reduction time and will therefore not produce data in a form suitable for publication for some time. Nevertheless, it is important that observatories such as the SAAO, which have a substantial number of long-term staff, should undertake these programmes which cannot be tackled by university and other small departments.

Radcliffe telescope

The outstanding event of the year 1975 has been the erection of the 74-inch (188-cm) Radcliffe telescope, which formerly stood on Klapperkop in Pretoria and which was dismantled late in 1974 and moved to Sutherland. The removal and re-erection in so short a time as 15 months, reflects credit on all concerned, including the Estates Department of the CSIR. It is hoped that systematic observations will commence very early in 1976. This fine telescope will of course add greatly to the importance and prestige of the Sutherland Observing Station.

New quarters at Sutherland

In addition to the four bedrooms in existing chalets, a new hostel for working astronomers has been built, consisting of six bedrooms, a large lounge, a dining room and a kitchen. The accommodation at the Sutherland Observing Station had already been commented on favourably by overseas visitors.

Visitors

The agreement between the CSIR and the Science Research Council of the United Kingdom whereby the SAAO observing facilities are available to visiting astronomers has continued to operate very satisfactorily. Astronomers working at Sutherland in 1975 have included individuals or groups from the University of London (UK), Royal Greenwich Observatory (UK), University of Manchester (UK), University of St Andrews (UK), University of Cambridge (UK), Royal Observatory, Edinburgh (UK), University of Oxford (UK), University of Cape Town, University of Texas (USA) and the University of Glasgow (UK).

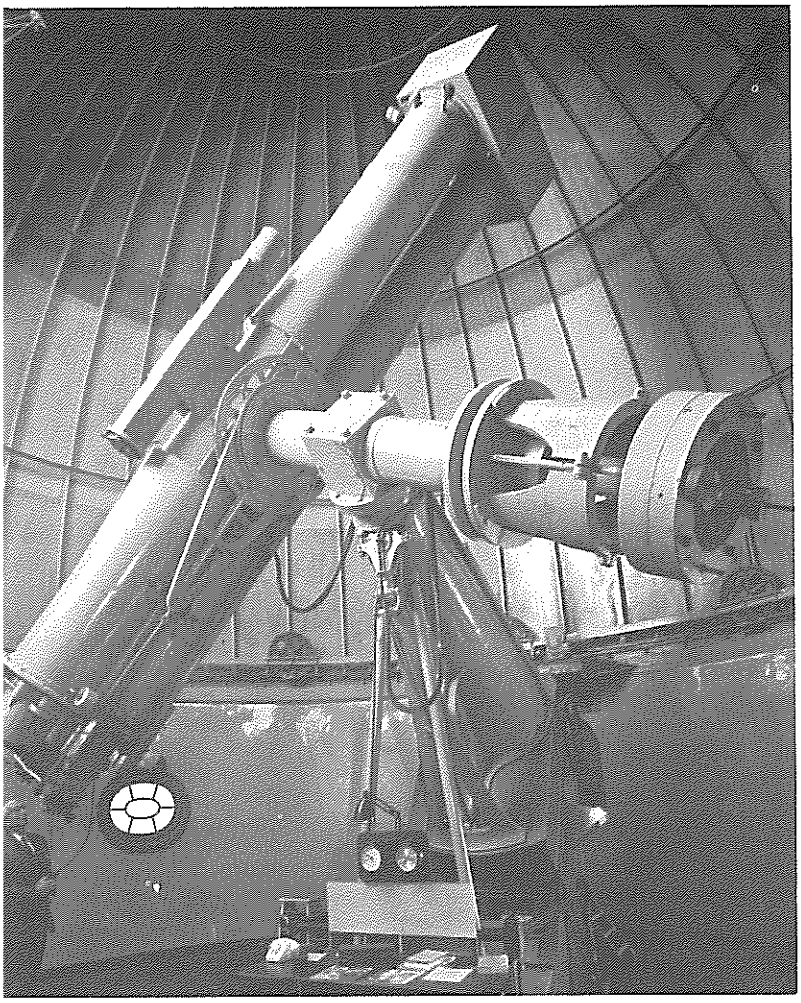
Eight distinguished overseas astronomers attended a symposium at SAAO in January 1975 to mark the retirement of Dr AD Thackeray from the post of Radcliffe Observer.

Studies of hot stars and XR sources

A number of problems connected xith hot, luminous (B-type) stars have been studied by SAAO astronomers using observations made with telescopes at Sutherland or at the former Radcliffe Observatory.

Some 25 of the hot stars vary in light and radial velocity with a period of a few hours. The cause of this variability is not understood. A recalibration of the luminosities of these stars has been carried out by using spectroscopic criteria. The results demonstrate rather clearly that the variables occur in a brief phase of stellar evolution when a particular star is adjusting to the exhaustion of hydrogen (its main nuclear fuel) near its centre. A further study of these stars is hampered by the small number known and a search for new members of the class is being carried out. Several have already been discovered.

There is considerable controversy as to whether these stars are pulsating in a simple radial manner or in a more complicated non-radial way. To help settle this question simultaneous spectroscopic and photometric observations of one of the variables have been made at Sutherland. Initial results favour the radial mode. Work on these stars is continuing.



The Victoria telescope with which more than 50 000 plates have been taken, most of them for the determination of stellar distances. For measuring the plates a precision two-coordinate comparator is used.

For some years the star α Cen has been unique amongst hot stars in showing periodic variations in the strength of the helium lines in the spectrum. As such it has been extensively studied at several overseas observatories. A second star of this kind has now been found and studied at the SAAO. These observations are consistent with the hypothesis that rotation of the star brings into view regions of the stellar surface with differing hydrogen to helium abundance ratios.

A large number of celestial X-ray sources have been detected from earth satellites. Few of these have been identified optically although the identification and study of these sources is of obvious importance in attempting to understand the manner in which the X-rays are generated. Spectroscopic and photometric work at SAAO and the former Radcliffe Observatory over the last few years has been successful in finding optical identifications or possible identifications for several sources both in our Galaxy and in our nearest extra-galactic neighbours, the Magellanic clouds.

Several of these sources appear to be hot stars interacting with unseen, very dense, companions. An important source of this type, initially identified at the former Radcliffe Observatory, has been extensively studied at the SAAO. It had been suggested by others that the light variations of the source could be understood if the hot star were distorted into an ellipsoidal shape by the presence of the unseen companion. The SAAO observations show that this model is inadequate at least in its published form. Spectroscopic and photometric work on several sources is being continued to further investigate their nature.

Stellar distances

A knowledge of the distances to the stars is required to determine their intrinsic brightnesses and masses, and their positions and motions with respect to the solar system.

It is possible to obtain distances to the nearby stars by using opposite ends of the Earth's orbit around the Sun to give a baseline and measuring the minute semi-annual displacements with respect to very distant, faint background stars.

Since 1839, when Henderson from his observations at the Cape produced the first reliable distance to a star, astronomers in South Africa have played an important role in this field. At present the SAAO is busy determining the distances to a selection of white dwarfs, particular stars put on the programme at the request of various astronomers, and several A type stars and nearby stars whose distances have so far only been poorly determined.

MO

geomagnetism

MAGNETIC OBSERVATORY

Head - A M VAN WIJK

Situated at the southern tip of Africa, the Magnetic Observatory at Hermanus is an important link in the worldwide network of geophysical institutions engaged in studies of physical processes occurring in the Earth's environment and in the interplanetary medium. Such phenomena are often closely related to the magnetic field extending outwards from the Earth and to cosmic rays incident on the Earth's atmosphere, and the variations of both are thus routinely measured. Besides its various monitoring programmes, the Magnetic Observatory conducts countrywide magnetic surveys, maintains magnetic standards and co-operates in national and international programmes.

In July 1975 the Magnetic Observatory took over responsibility for the South African Antarctic programme for geomagnetism and aurora from Potchefstroom University.

Research at the Observatory consists of the analysis and interpretation of a variety of geophysical data.

Geomagnetism

The Observatory's geomagnetic monitoring programme provides a continuous record of variations in the Earth's magnetic field at six recording stations, viz. Hermanus (established 1941), Tsumeb (1964-), Hartebeesthoek (1972-), Grahamstown (1974-), Sanae (1960-) and Marion Island (1972-).

The final phase of the countrywide magnetic secular variation survey was completed in June 1975. The observed field values are being used to compile isomagnetic charts for the epoch 1975,0. A research report describing recent trends in the secular variation in South Africa was presented at the IUGG meeting in Grenoble in August.

Cosmic rays

Operation of the Chalk River neutron monitor (type 12-NM-64) continued throughout the year. The monitor comprises two separate neutron monitor piles: a 9-NM pile with conventional polyethylene shielding, and a 3-NM pile with polyethylene *plus* paraffin wax shielding. An investigation was started into the cause of the small but significant 'annual variation' in the ratio of the counting rates of the two sections.

Ionospheric observations

A 30 MHz riometer is used for routine measurements of ionospheric absorption by monitoring the power level of cosmic radio noise propagated through the ionosphere.

The VLF (27 kHz) receiver at Hermanus once more recorded several SEA's (Sudden Enhancements of Atmospherics) of the type associated with enhanced electron density in the ionosphere. The riometer and VLF recordings together provided immediate confirmation of suspected geomagnetic solar flare effects recorded at Hermanus.

As in the past, the Observatory operated a Wadley ionosonde for the National Institute for Telecommunications Research (NITR). The data are processed at the NITR and published in its *Monthly bulletin of ionospheric characteristics.*

Aurora

Routine auroral observations, both visual and with the SCAR type all-sky camera, were continued at the South African Antarctic base, Sanae. Since the present all-sky camera has deteriorated with age a new system is being assembled as a replacement.

Observations of auroral pulsations were made of radiation from the 4278 ÅN_2^+ band at three points in the sky during selected auroral events. The results are not published on a routine basis, but are available on request.

Observations of proton aurora were commenced during 1975 using a tilting filter scanning Hβ photometer. A second Hβ photometer of improved design is under construction.

Technical developments

The specialized equipment required for measuring the geomagnetic field components is generally not commercially available; the Magnetic Observatory, however, had considerable success in designing and constructing its own equipment.

The mechanical workshop has succeeded in converting a theodolite into a non-magnetic magnetometer base. Several declinometer attachments have also been built.

An FHY digital magnetometer using a cesium probe as sensing unit is being developed by the electronic workshop.

Geophysical alerts

Geophysical research units and other interested organizations in South Africa are advised of the onset of magnetic and ionospheric disturbances with the minimum of delay. The messages are relayed through the communications network of the Weather Bureau.

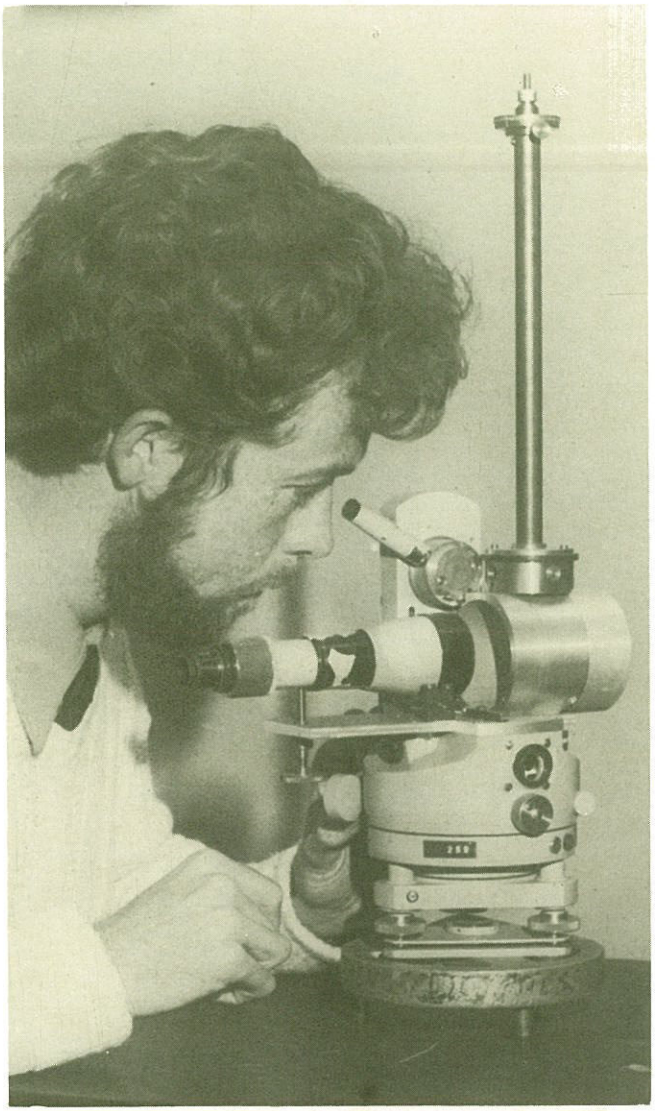
Magnetic activity indices

The Magnetic Observatory at Hermanus is one of the few magnetic stations whose data have been selected for use in the determination of the 'planetary' indices of magnetic activity, Dst and Ks. The monthly tabulations of Hermanus data are supplied to the relevant international centres as soon as possible after processing.

Research

Various geophysical time series were studied using the maximum entropy method (MEM) of power spectrum analysis. The analyses resulted in the confirmation of minor lunar variations in the Hermanus magnetic data, in the detection of annual and semi-annual lines and associated harmonics in worldwide geomagnetic data, in the resolution of the harmonic structure of geomagnetic pulsations, and in a more accurate estimate of the Chandler period.

The study of magnetic quiet-day variations has been continued. It was found inter alia that in the Europe-Africa zone the mean latitude of the two foci of the equivalent overhead current system move northward and southward with the sun.



This instrument, a theodolite converted into a magnetometer base, is used in making declination measurements.

NRIO

NATIONAL RESEARCH INSTITUTE FOR OCEANOLOGY

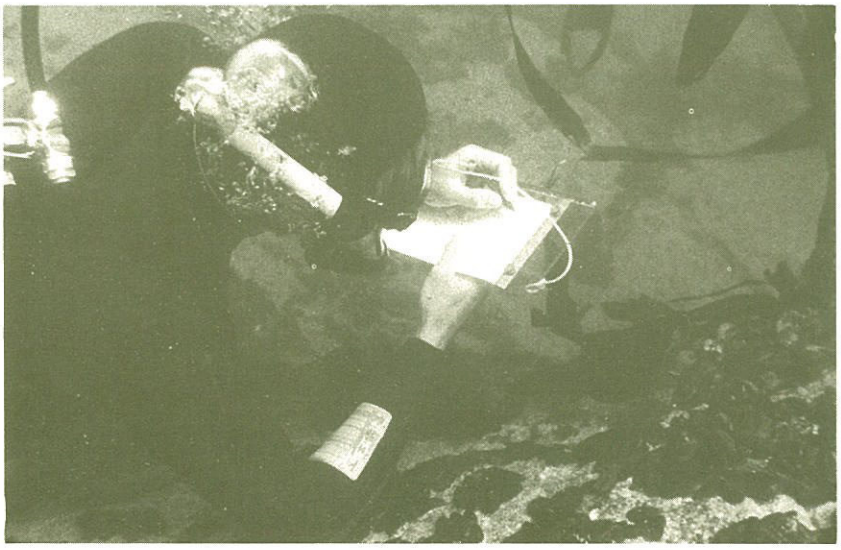
Director - DR E S W SIMPSON

oceanology

During its first eighteen months as an Institute of the CSIR, the National Research Institute for Oceanology (NRIO) has made significant progress in co-ordinating the various programmes of CSIR marine-related work, and has begun to draw up a plan for a broad multi-disciplinary programme in marine science.

The Institute, with its headquarters at Stellenbosch, consists of divisions of physical oceanography, marine geoscience, marine chemistry, marine biology and coastal engineering and hydraulics.

Studies are being undertaken to obtain data in the oceanic areas around South Africa as well as to provide data and knowledge needed in the continued development of our coastal areas for economic and recreational use, and for resource exploitation.



A marine biologist making notes on the fauna in a typical kelp bed off Oudekraal near Cape Town in 12 metres water depth.

Physical oceanography

Studies of the Agulhas Current continue, with the emphasis at present on beginning an integrated study of the interaction between the main current and the nearshore circulation pattern. Earlier studies have indicated that the nearshore boundary of the current shifts and that large eddies are periodically developed within the main core. More recently, oceanographers have noted large-scale changes in the surface flow velocity as well. It is important to know whether this reflects only a surface effect or is indicative of great changes in mass transport, i.e. extends to greater depth as well. Repeated occupation of oceanographic stations in the current over a long period of time will allow collection of the salinity and temperature data at various depths necessary to calculate the mass transport.

Analysis of currents on the continental shelf shoreward of the Agulhas Current has shown variations in current direction and speed, factors of obvious importance to shipping interests and those concerned with beach processes. Further studies will include the placing of bottom-mounted current meters to study these phenomena over a period of time. This programme will be closely co-ordinated with the Agulhas Current study to examine possible cause and effect.

The NRIO is working closely with the United States and Australia in a programme to launch free-floating buoys in the Southern Ocean and to monitor data received from the buoys by earth-orbiting satellite. Following the successful launch of the NIMBUS 6 satellite by the United States in June 1975, the *Meiring Naudé* set sail in August to set two buoys adrift as a sea trial. If this

A member of the pollution monitoring team prepares a seabed suction sampler.

is successful, the South African Department of Transport supply vessel, the *RSA*, will launch eight more buoys in February 1976. It is hoped that the surface temperature and barometric pressure data retrieved from the buoys will be the first step in a larger, global programme.

Marine geology and geophysics

A reconnaissance survey of the submarine continental borderland north of latitude 25 degrees South was well under way in 1975, in conjunction with the Marine Geology Unit of the University of Cape Town. Detailed studies of the morphology of the shelf and slope areas allowed comparison with corresponding features elsewhere in the world.

The main emphasis of the study was on the sediments of the continental shelf, and the distribution of sediments was found to be the result of a variety of such factors as the geology of the source area, the chemistry of the ocean waters, and reworking by marine organisms. Particularly significant is the finding of marine phosphates and glauconite off the Kunene River mouth. These minerals are of industrial importance and may constitute a potential resource. Sedimentology studies were also undertaken in the Saldanha Bay-Langebaan Lagoon area to provide the Department of Planning and the Environment with basic information for environmental control purposes.

The revolutionary developments in instrumentation in marine geology and geophysics are being studied and contributed to by NRIO scientists and technicians. Side scanning sonar was used in January and February 1975 to study large migrating sand dune fields that had developed on the seabed below the Agulhas Current.

The Deep Sea Drilling Project (DSDP) vessel *Glomar Challenger* drilled two sites to a total sub-bottom depth of 1 314 metres in the Cape Basin. Actual drill site selection was based upon earlier oceanographic expeditions, including two cruises jointly run by the NRIO, University of Cape Town and the Scripps Institution of Oceanography, San Diego, California. The DSDP results at this site are providing important information on the origin of the South Atlantic Ocean. The NRIO has a continuing presence in the activities of this international drilling programme through the researches of a new staff member whose outside commitments include co-ordination of South Atlantic geological research based on drilling results.

Through its Director, the NRIO maintains close liaison with such international bodies as the Commission for Marine Geology of the International Union of Geological Sciences and the Scientific Committee on Oceanic Research (SCOR). The NRIO was host to the annual meeting of the SCOR Executive Committee in Stellenbosch in November.

Marine chemistry

The activities in the field of marine chemistry has been associated with assessing man's actual and potential pollution of the marine environment.

Deep sea water sampling at various depths was continued along transects 100 km due south of Cape Infanta and 100 km due west of Saldanha Bay, both as a tie-in to global studies of the chemistry of major water masses and also to provide base line values for nearshore work of more immediate concern. Nearshore samples were also collected from areas remote from man's activities to serve as further reference.

During 1975, water, sediment and faunal samples were taken from a number of beaches in the False Bay-Table Bay areas and were tested for different types of chemical pollution. Some areas, notably Camps Bay beach, are relatively unpolluted, while others, for example beaches in the Cape Town harbour and Simonstown areas, show signs of heavy pollution.

Experiments were begun with those marine organisms thought to be sensitive indicators of pollution; these include larvae of a common sea urchin and certain species of limpets. It is hoped that fast and reliable field tests for pollution will be devised, using these indicator organisms.

Marine biology

The kelp bed project, an investigation undertaken jointly by the NRIO, the University of Cape Town and the Sea Fisheries Branch, was begun in 1974 in order to provide data for the optimum management of this valuable natural resource and of the rock lobster and abalone fisheries which are largely dependent upon it. The first phase of this programme, the measurement of the biomass of both plants and animals at the study site off Oudekraal (near Cape Town), was completed in 1975. The second phase, already started, aims at following the flow of energy from the primary producers (kelp and other algae) along the main pathways of the food web. This should hopefully lead to a model which may be used to predict changes caused by economic exploitation of either plants or animals in the system.

Quantitative studies of oceanic plankton have been undertaken by marine biologists as a non-physical parameter for tracing water masses. Taxonomic analysis of 360 samples has revealed the presence of three distinct assemblages of copepods (planktonic marine crustaceans), each of which are related to physical (temperature, salinity) and chemical (silicates and nitrates) parameters representative of three major water masses. Since there is little overlap of range, these populations make excellent water mass indicators.

Coastal engineering and hydraulics

New facilities were built at Stellenbosch to house dynamic models of the proposed Koeberg nuclear power station intake and of Gansbaai harbour.

The Koeberg model, at a scale of 1 in 80, will simulate a proposed cooling water intake basin in the form of a small harbour. The basin will be designed to protect the intake structures, to reduce water level fluctuations due to wave action, and to act as a settling basin to prevent sand from entering the cooling system.

The model of Gansbaai harbour, at 1 in 80 scale, will be used to solve problems of wave penetration, overtopping, and damage to the harbour units experienced at the new extensions to the harbour. This is a joint study with the Fisheries Development Corporation.

NMERI

NATIONAL MECHANICAL ENGINEERING RESEARCH INSTITUTE

Director - DR H G DENKHAUS

mechanical engineering

While the National Mechanical Engineering Research Institute (NMERI) is concerned mainly with the development of new processes, techniques and equipment in mechanical engineering as well as the improvement of machines and materials used in industry, it is also active in fields such as geomechanics for both mining and civil engineering as well as in civil engineering hydraulics. Testing equipment, machines, instruments and qualified personnel are available for research in six divisions covering the fields of metallurgy, strength of materials, process development, geomechanics, fluid mechanics and heat mechanics (including air conditioning and refrigeration). There are also two research units, the one dealing with aeronautics and the other with mine equipment.

The six divisions and the Aeronautics Research Unit are housed in Pretoria, while the Mine Equipment Research Unit is accommodated in Johannesburg. The two units are integral parts of the Institute and are directly responsible to the Director of the Institute.

Powder metallurgy

Materials possessing certain desired properties can often not be produced by the conventional method of alloying several metals in certain compositions. Typical examples of such materials are those used for electrical carbon brushes and self-lubricating bearings. In such cases the material is produced by applying powder metallurgy.

Powder metallurgy has as yet not been applied in South Africa and components like copper carbon brushes have to be imported. The Metal Mechanics Division is therefore investigating applications of powder metallurgy and has made a start with studying the production of copper carbon brushes to build up the necessary know-how for the development of the best methods of manufacturing high copper content carbon brushes for use in the electrical industry.

Fatigue of metals

Some decades ago, it was realised that a component of a machine or structure which did not fail or yield under the application of a static load may fail suddenly after some time when subjected to alternating loads. This phenomenon is known as material fatigue. To determine the fatigue strength of materials tests were developed from which the so-called 'fatigue limit' of the material can be obtained. This is the maximum allowable alternating stress at which the material will not suffer fatigue failure even if the load is applied for up to, say, 10 million loading cycles.

In most fatigue tests used in the past the load cycles were applied with constant amplitude of cycling. Some catastrophic aircraft failures, however, illustrated dramatically that fatigue damage sustained by an actual component depends not only upon the amplitude of the load but that fatigue damage sustained by an actual component depends, inter alia, also to a large extent upon the sequence and number of occurrences of high and low loads, that is, upon the load 'spectrum'. These effects cannot be investigated by constant amplitude fatigue testing. It is now accepted world wide that the design of components for a limited fatigue life, such as for instance an aircraft wing, must be based upon results of tests with what is called random fatigue loading spectra.

Installation of a scale model flight vehicle on the free-flight model launch gun of the supersonic wind tunnel. The purpose of free-flight tests is to deduce the flight dynamics characteristics of a vehicle from analyses of the motion of a model in the wind tunnel.

Using an electro-servo-hydraulic testing facility recently installed in the Strength Mechanics Division, any type of loading spectrum can be applied to actual components, and a more realistic picture of the probable fatigue life of the component may be obtained. It is also possible to simulate actual load spectra by obtaining magnetic tape recordings of stresses in prototype components with the aid of strain gauges. These tape recordings can then be used to excite the control system of the servo-hydraulic testing facility in order to apply the actual loading pattern on the component under test.

Milling of minerals

The control of the reduction works on mines is almost exclusively still being done manually by shift operators. On their regular rounds during a shift they have to ensure that certain instruments maintain specified readings by, for example, altering the setting of valves, speed of driving motors and so on.

Ways and means of introducing automatic control systems are at present being investigated, however, because this should ensure a more consistent product from the plant than is possible with manual control. Research into the automatic control of continuous ore grinding mill circuits is in progress in the Process Mechanics Division using a 1-metre diameter ball mill complete with a cyclone classifier to recirculate over-sized milled rock back to the mill for regrinding. The mill test circuit has been instrumented so that such parameters as the rate of rock and water feed to the mill, the rates of flow and densities of the slurries to and from the cyclone and particle size can be monitored automatically, and eventually be controlled by computer. In the meantime systematic tests are being done to determine the behaviour of the system, when controlled manually.

Chilling, storage and freezing of meat

In the past the Heat Mechanics Division conducted research into the chilling, storage and freezing of meat under practical conditions in various abattoirs throughout the country, for which it received international recognition. This work is now being continued in a cold room complex specially designed by the Division for basic research in which the various parameters influencing chilling and freezing can be altered as desired in a manner that was not possible in the earlier research.

Basic studies are being carried out in this complex to determine the effect of the environmental conditions during chilling, storage and freezing of meat on its quality. For example, the rate of cooling of various muscles within the carcasses is continuously recorded during the chilling cycle, to investigate the phenomenon of 'cold-shortening' or toughening of meat. The research team under the project leadership of the Division consists of members from the Veterinary Research Institute at Onderstepoort (where the complex is situated), the Animal and Dairy Science Research Institute and the Livestock and Meat Industries Control Board.

Recovery of gold from slimes dams

At the present price of gold the possibility of recovering any remaining gold that may exist in old gold slimes dams is being investigated in the gold mining industry. To improve the viability of the project it is intended to recover uranium, pyrite and possibly other materials as well.

The project ultimately has in mind the establishment of a centrally located processing plant to which the material from the slimes dams will be pumped in the form of slurries in hydraulic transportation pipelines. Once the slime has been processed it will be transported again, by pumping in a hydraulic pipeline, to one large 'super' slimes dam to be built far from built up areas.

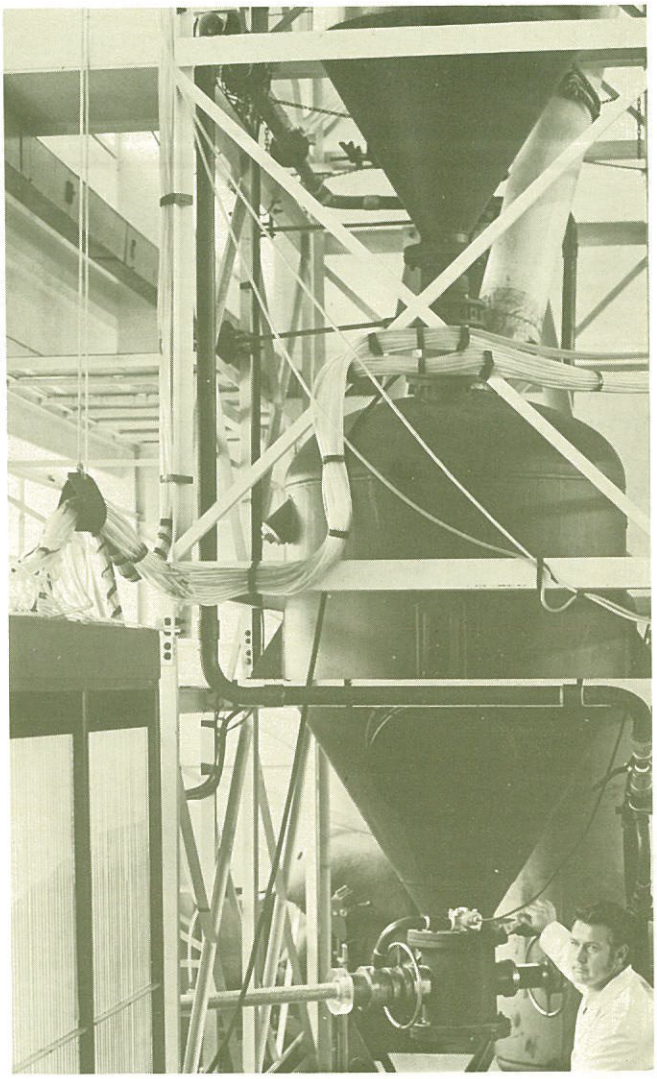
The Fluid Mechanics Division was requested to assist in a technical investigation to establish the feasibility of transporting up to 18 million tons of slurry per annum. To this end the hydraulic pipeline test circuits installed in the Institute were used. The pressure against which the pumps will be required to pump using slurries from two different mine dumps was determined, and it was proved that it is technically feasible to transport the planned quantities in three pipes each 450 mm in diameter.

Pneumatic transport of granular solids

A convenient method of handling granular materials, such as agricultural products, other than by such conventional mechanical means as conveyor belts or bucket conveyors is by pneumatic means in pipelines. Although the principles involved are well known, this form of materials handling, particularly in the field of agriculture, has not been extensively used in South Africa.

In order to gain experience a study rig was built using Perspex pipes 50 mm in diameter. Because the pipeline is transparent, the flow of material is visible and blockages etc. can be easily observed. Means for measuring the pressure in the pipeline are provided. An important element of any pneumatic system is the feeder system by which the solids are introduced into the line. In the experimental rig a nozzle is used whose distance to the entry pipe is variable and through which air is supplied to draw the solids into the entry pipe.

To date sorghum has been the test material used, and it is intended also to carry out tests on other agricultural products such as wheat and maize.

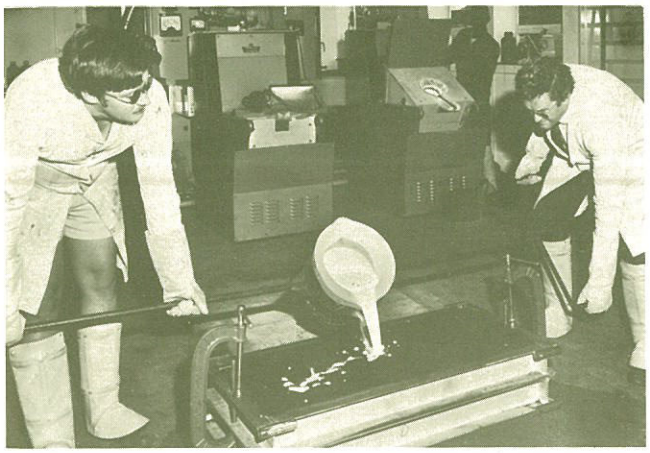


A test rig for research into the pneumatic transport of granular material.

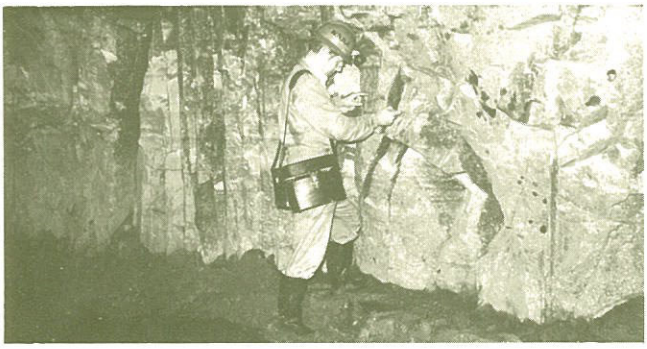
Drakensberg hydro-electric scheme

The Drakensberg pumped-storage scheme is a hydro-electric project from which it is expected to generate electric power to the tune of 1 000 MW. Forming a part of the Tugela-Vaal Scheme, it is a joint undertaking of the Electricity Supply Commission (ESCOM) and the Department of Water Affairs.

The crucial part of the scheme is an underground power station. At the request of ESCOM, the Geomechanics Division undertook a study in 1974 to determine the feasibility, from a rock mechanics point of view, of excavating the large caverns in the rock formations encountered at the Drakensberg site.



The Metal Mechanics Division also investigates foundry problems. Here a test casting is being made.



Determination of the various characteristics of fractures in rock masses, especially in underground situations, is a difficult and demanding task.

The information necessary for determining the rock mass conditions was specified and a site exploration programme aimed at obtaining this information was carried out. It was concluded that excavating the underground caverns would be feasible if special attention was paid to the shape of the excavations and if the rock reinforcement together with the construction method as well as the excavation sequence were carefully designed. On the basis of the recommendations resulting from the feasibility study, ESCOM decided to proceed with the scheme.

Tests on mine hoist ropes

By law, every steel rope used in the mining industry for hoisting raw materials and rock has to be tested every six months to determine its breaking load. To comply with the law a length is cut off the end of a rope and sent to the Mine Equipment Research Unit at Cottesloe, Johannesburg, which is the testing station in South Africa responsible for all such statutory testing. Between 4 000 and 5 000 ropes are tested annually.

An accurate record is kept of the life of every winding rope used in the mines, from the time it is manufactured until its breaking load has diminished to a value specified by law when it has to be discarded and replaced by a new one; in normal practice, however, the rope is replaced before this stage is reached. The Unit also tests ropes for mines situated outside South Africa. During the past year more than 1 000 ropes were tested for such mines.

Because of the great depth of many mines in South Africa, problems that are peculiar to this country are experienced with the design of steel winding ropes. Therefore research is also being undertaken at the Mine Equipment Research Unit on behalf of the only mine winding rope manufacturer in South Africa to ensure that the ropes used in the mines meet local conditions perfectly. Proof of the high quality of locally manufactured ropes is the fact that many are exported to foreign countries, especially in Africa, but also to South America and Australia.

Supersonic free-flight wind tunnel testing

In conventional wind tunnel tests, the model of a flight vehicle under test, which could be an aircraft, missile or spacecraft, is usually held stationary in the test section of the tunnel while forces or pressures acting on it are measured as the air in the tunnel passes over it. When conditions deviate substantially from unaccelerated flight, as is the case for most missiles, information is required about the stability characteristics of the model in free flight, and it is essential that the model should not be held stationary but that it should be flying free of any restraint.

A facility was designed and built in the CSIR to make it possible for the model to be projected into the airstream of the supersonic wind tunnel facility at the Aeronautics Research Unit. The desired stability information is obtained from analyses of high-speed cine photographs taken during the short period of time that the model can be observed. This capability, which is shared by only a small number of laboratories in the USA and Europe, is virtually indispensable in wind tunnel investigations of flight vehicle dynamics.

Until fairly recently, the facility only provided for the two-dimensional observation of the models' behaviour, that is, the motion in a single plane. The facility was, however, extended to provide full three-dimensional visualization of the models.

The purpose of free-flight tests is to deduce the flight dynamics characteristics of a vehicle from analyses of the motion of a model in the wind tunnel. Since these characteristics depend strongly on the extent to which the vehicle is pitching, yawing and rolling, it is always necessary to simulate the three-dimensional nature of the motion. A unique launching device was designed by which the motion of the model can be controlled to simulate accurately the motion of the vehicle. A system of air jets is provided in the launching head to impart the desired angular acceleration to the model as it separates from the launcher. This system was developed, in particular, to provide a means for testing models which are highly manoeuvrable or marginally stable; this has not previously been possible.

NEERI

NATIONAL ELECTRICAL ENGINEERING RESEARCH INSTITUTE

Director - J D N VAN WYK

electrical engineering

The National Electrical Engineering Research Institute (NEERI) is concerned with light-current and heavy-current research in the field of electrical engineering. The Institute consists of divisions for applied electronics, automation, electronic instrumentation, power electrical engineering, signal processing, solid-state electronics, and training and information. Work is done in such diverse fields as computer technology, process control, the application of digital techniques to data processing, information theory and signal processing, medical electronics, semiconductor and thin-film technology and its applications to electronic circuit systems and microminiaturization, and the investigation of problems peculiar to South Africa in heavy-current applications.

Lightning counters

The importance of lightning as a parameter which has to be considered during the design of power systems and communication networks is being increasingly realized. The shortcomings of the existing measure of lightning activity, namely the thunderstorm day, are generally appreciated, as it is well known that the actual lightning activity is not directly proportional to the number of thunderstorm days.

The most direct indication of ground lightning activity is the number of lightning discharges to ground per square kilometre per year. From the standpoint of the engineer, this ground lightning density is of primary importance, although in regard to air transport discharges between and within clouds are also important.

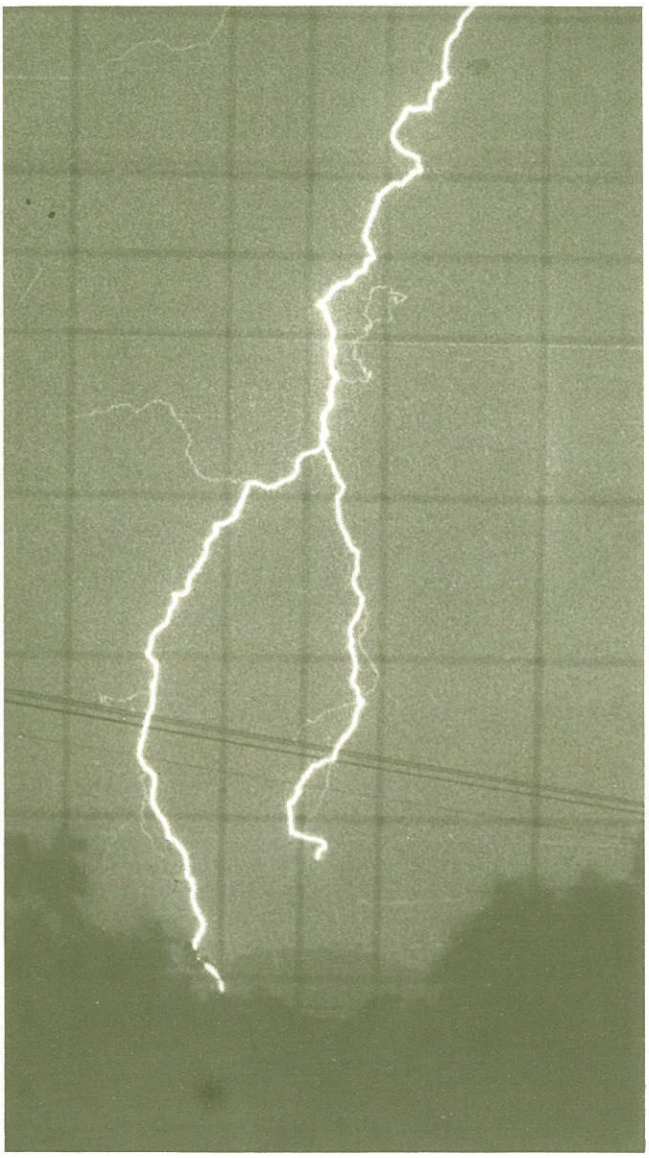
About eight years ago a programme was initiated with the ultimate aim of determining the ground lightning density for the Republic and South West Africa. For this purpose it was necessary to develop and calibrate suitable lightning counters. A stage has now been reached where the locally developed lightning counter (the RSA 10-A) is being used throughout the country for measuring lightning discharges to ground.

By making use of funds contributed by the Electricity Supply Commission (ESCOM), the South African Broadcasting Corporation (SABC), the Post Office, the South African Railways and the CSIR, it was possible to order about 400 lightning counters of the above-mentioned type, most of which have already been supplied and distributed.

Lightning parameters

About three years ago it was decided to initiate a local programme of direct recording of lightning currents. A 60-metre mast was erected on an insulated base so that current sensors could be installed at its foot.

With the co-operation of the Decca Navigator Company additional current measurements could be made using magnetic links on two high masts (107 m and 122 m) elsewhere in the country.

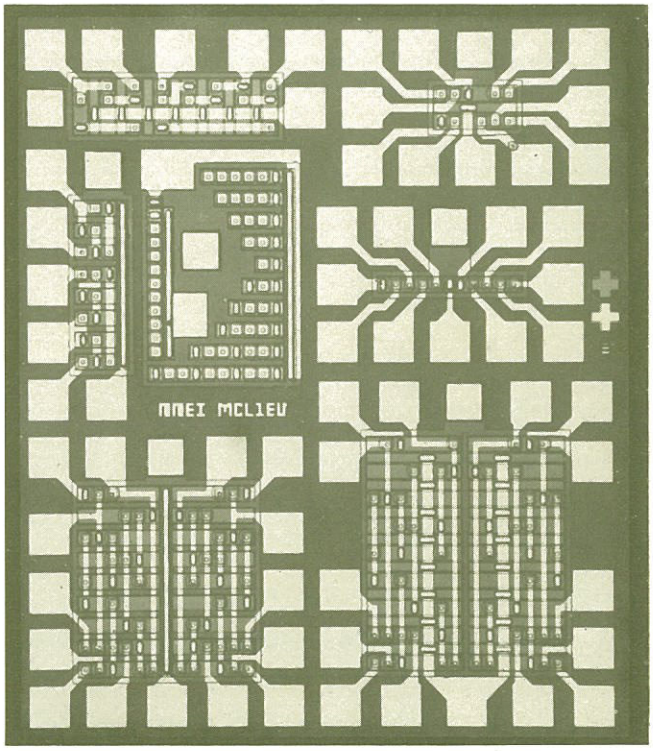


An unusual case of a downward lightning flash exhibiting two ground terminations, one of which is the lightning mast at the CSIR.

Production of bipolar microcircuits

The background to the proposed facility for manufacturing bipolar integrated circuits was described in the previous annual report, and here it will thus be merely recalled that the development is intended mainly to supply a need for a local installation for the production of custom-made integrated circuits for strategic and other use. A licence agreement was signed with a semiconductor manufacturer for this purpose.

During the past year a beginning was made with the construction of the required building on the CSIR site in Pretoria. Most of the key personnel have been engaged, and lately they have been fully employed making a final selection of equipment.



The first successful MCL test circuit produced by the NEERI. *Actual size:* 2,2 x 1,8 mm.

Battery-driven vehicles

The Institute is involved in two projects which have been undertaken in co-operation with the Committee for Battery-driven Vehicles, which is responsible to the Department of Industry. One project is a theoretical study of a vehicle which has a battery as its primary source of power and a flywheel as a booster source. The other project involves testing electric vehicles which have been made available to the Institute, the aim being to evaluate the efficiency of the electrical systems and their suitability for local conditions.

Design of microcircuits

A programme has been initiated to produce small quantities of integrated circuits in the laboratory by the standard process. The experience gained in this way will, it is hoped, expedite the design of circuits which are to be manufactured in the the production facility.

Multi-collector logic (MCL) is a new circuit technique which, employed in conjunction with the standard bipolar technology, can produce digital circuits with a very high packing density and very low power consumption. For these reasons it is very desirable that it should be possible to design MCL digital circuits locally and make them in the production facility.

The first test circuit has been successfully completed, and it paves the way for further developments in this technique and the design of custom-made digital circuits for production.

An uncommitted circuit has been designed, containing numerous components which are so laid out that a large number of different electronic functions can be realized by employing different connecting patterns. During manufacture, all the processing steps will be carried out with the exception of the final etching of the connecting pattern, and a supply of silicon wafers with these circuits can then be built up. The final step defining the connecting pattern depends upon the specific electronic function which the circuit is to carry out.

MOS integrated circuits

Metal-oxide semiconductor (MOS) structures and integrated circuits play an important role in modern microelectronics.

The first simple MOS integrated circuit entirely manufactured in South Africa was functionally demonstrated in 1974. The process was completely developed at the CSIR, and the critical oxidation process was carried out at a particularly low temperature. It has recently become possible to produce relatively simple systems for opto-electronic picture and signal processing with important military and other applications.

By making use of the irreversible voltage breakdown characteristic of MOS gates, it is possible to produce read-only memories which are programmable by the final user and thus do not have to be programmed during manufacture. Such a memory has been designed and is being processed.

Design and construction of masks

The computerized system for laying out masks for circuits is rendering good service and during the past year various sets of masks for integrated circuits were designed, not only for internal use but also for external organizations.

The automation of the mask cutting table has been successfully completed and a numerically controlled optical mask making machine ordered by the Technical Services Department was delivered during the year. The step-and-repeat camera used to produce the masks in their final size has been improved and the full potential of the camera has now been exploited. Any noteworthy further upgrading of size or quality of masks can only be achieved by acquiring more modern equipment.

Process control in industry

In co-operation with a gold mining company a project is being undertaken with the ultimate purpose of reducing the gold losses during the reduction process. The immediate aim of the project is to make a study of the efficiency of drum filters under various operating conditions. This is being done by gathering operational data with the aid of a computer system, and then analyzing the data in order to establish a mathematical model of the filtering process.

The necessary measuring instruments were installed by the company concerned, and the CSIR provided data recording equipment. The data obtained are being processed with the aid of computer equipment at the CSIR. It is intended to deliver a paper on filter simulation at an international symposium during 1976.

A sugar company approached the Institute with a request to co-operate in an automation project including the development of a computer-controlled system for part of the company's refinery. The project will extend over a period of three years, and this Institute will contribute by lending a process computer, developing computer programs and interfaces, analyzing data and developing a control strategy. The company will provide and maintain all sensors, transducers and controllers.

Simulation of aquifer

The simulation of an aquifer for the Hydrological Institute of the Department of Water Affairs has been completed. In co-operation with the National Institute for Water Research it is now intended to undertake the simulation of the aquifer of the Cape Flats. All available data are at present being evaluated with a view to making a recommendation on the type of model and the simulation medium.

Processing of ERTS data

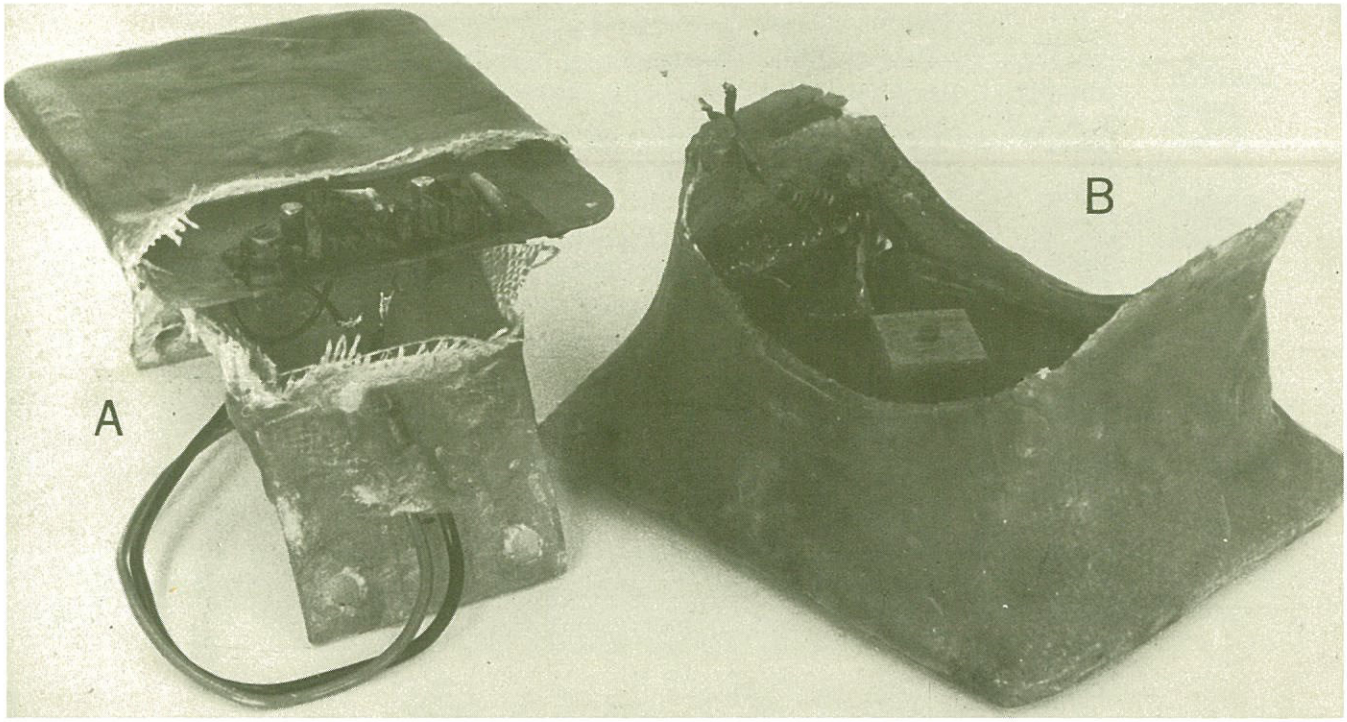
The American ERTS programme (Earth Resources Technology Satellite programme) makes data available to countries which participate in the programme. The information can be obtained on digital magnetic tape, which is particularly suitable for computer processing. The light reflected from the surface of the earth is scanned by the satellite in four different spectral bands: a green band, a red and two infrared. Every picture element thus consists of the reflection coefficients for the four bands, and since different surface features have different characteristics it is possible, for instance, to identify types of vegetation.

The Institute has developed methods, based on the use of the available computer equipment, of selecting all points having the same characteristics as those of a given reference point on the picture. This work is being done in co-operation with the National Physical Research Laboratory and the National Research Institute for Mathematical Sciences.

Medical electronics

Since 1971 the Institute has been active in the development of small telemetering systems for transmitting physiological data, and simple single-channel and two-channel systems have been operated successfully. A seven-channel system is at present being developed.

In order to gain a better insight into the behaviour of radio waves inside a building, and to determine the most favourable frequency band, extensive field strength readings were taken in a small laboratory building. The experiment was carried out for the frequencies 115 MHz, 500 MHz and 1 GHz, and the most effective frequency band for telemetry within the building was found to be 500 MHz, which is considerably higher than the 115 MHz band used up to now.



Animal tracking transmitters recovered in the veld after exceptionally severe service. Transmitter A shows advanced corrosion and the effects of electrolytic action, but in spite of this could still function after having been dried out. Transmitter B was recovered after more than a year, but was also still in working order.

Animal tracking

Results obtained when tracking wild animals with the aid of miniature transmitters compare well with those achieved overseas, but the transmitters proved to be insufficiently reliable, especially for use on a large scale. Special attention was thus devoted to this aspect during the past year, both by making use of a climate chamber and by exposing transmitters in the open.

The findings led to the circuit being modified so as to cope with a wider temperature range and cause it to be more moisture-proof.

Electromagnetic interference

Where sensitive electronic devices are required to operate in the vicinity of heavy electrical equipment the effect of electromagnetic interference is an important design consideration. Measuring equipment for determining the extent of such interference is available in the Institute.

The radio regulations were modified in November, 1973, with a view to ensuring that equipment which could possibly interfere with television reception would be fitted with suitable suppressors. In those cases where a device does not comply with the requirements the Institute provides a service to industry by making available information on the design and construction of the necessary filters and other means of suppression, or even by itself carrying out the necessary work of design and construction.

Training of technicians

The Institute is responsible for the practical training of students who take the four-year sandwich course at the Pretoria College for Advanced Technical Education. During the past year two CSIR students did particularly well. One was awarded a silver medal as the best student in the Electrical Engineering Department, while the other received his Diploma after gaining nineteen distinctions.

CERG

chemical engineering

CHEMICAL ENGINEERING RESEARCH GROUP

Head - W G B MANDERSLOOT

Chemical Engineering deals with the processes and operations by which the properties or composition of matter in bulk are changed. Thus the activities of the Chemical Engineering Research Group (CERG) cover not only the needs of the chemical industry but also many processing aspects in the petroleum, petrochemical, mineral, food, beverage, biochemical, pharmaceutical, ceramic, paper and textile industries, and in environmental technology (in which water, effluents and air are important). The interdisciplinary nature of chemical engineering provides a useful link in carrying out tasks undertaken in close co-operation with other institutes and organizations.

The research and development items on the Group's programme are selected according to the immediate and anticipated needs of industry. The Group provides a wide range of consulting services to industry. If necessary these services are backed up by applied or fundamental research.

Services to industry

Over the years, the Group has developed a series of services which, judged by the demand encountered, have found wide usage. These services are available to any industry or individual and comprise the following:

- *Process technology* — For long-term as well as short-term investigations the Group's semi-technical scale equipment for drying, mixing, extracting, etc. is utilized. This also includes advice and information required in solving certain processing and related problems. The number of enquiries handled increases every year.

  The dynamic simulation of a long gas pipeline with intermittent take-off was undertaken under contract and a suitable computer program has been made available for general use.

  A paper on process simulation in water reclamation was presented at a symposium in Johannesburg.

- *Particle characterization* — The Group's range of particle characterization equipment was extended further with the acquisition of an X-ray sedimentometer and an automatic BET absorption instrument for the determination of particle surface areas. A considerable number of samples were characterized. In many instances further advice was given on related process problems which arose from the interpretation of the results of the samples characterized for industry.

- *Evaluation of manganese dioxide* — This service comprises the evaluation of manganese dioxide ore samples for utilization in the manufacture of small batteries (dry cells). The instrument used is the Pulse Galvanostatic Analyser (PGA) which was developed by the Group. Besides testing samples from various sources, an analyser was again supplied to an overseas battery manufacturer.

- *Design of heat exchangers* — The design and rating service makes use of computer programs for cost-optimized design and for performance evaluation. These computer programs are either developed by the Group or obtained elsewhere, e.g. from the Heat Transfer and Fluid Flow Service of AERE at Harwell, UK, with which close co-operation has been established.

  A guide was issued on how to supply the information required f the computer rating of air-cooled fin-tube heat exchangers.

□ *Prevention of air pollution* — The services offered in this field consist of the sampling of emissions, the provision of 'tailor-made' sampling equipment and the giving of advice on the control of emissions.

A marked increase was encountered in the demand for the measurement of industrial emissions. The measurements mostly concerned the dust load of the emission and usually included a particle size analysis of the dust. In certain cases, the emissions were also tested for gases.

Emissions were measured at the boilers of two power stations; at the rotary kilns of a steel works, a vanadium plant and an asphalt plant, at the baghouse of a copper smelter; at the cyclone of a detergent plant and at boilers and soda recovery furnaces of a paper mill. Some of these measurements were performed in order to assess the requirements for the installation of dust arrestors while others served to check on the effectiveness of newly installed emission control equipment. In one instance assistance was given in the simultaneous measurement of dust loads before and after an electrostatic precipitator.

A high-speed mixer used for semi-technical process work in the laboratory.

Advice on the sampling or analysis of emissions was given — in some instances after site inspections — concerning the emissions from a cement works, carbon black plant, asphalt plant, saw mill, urea plant and arc smelter.

Two complete sampling trains were manufactured by the CSIR's Technical Services Department. The designs were adapted to the particular requirements of the outside firms concerned.

In addition, advice and information was given in answer to a host of enquiries received on the control of emissions.

The services provided to industry are usually conducted on a contract basis and the results obtained remain confidential.

Particle technology

The Group's activities in the field of particle technology have their accent on solid/fluid separation processes and on particle classification processes (by size or density).

Particle characterization is an essential prerequisite for this research, which is of particular interest to the minerals processing industry. A one-week course on particle characterization, which was attended by 50 participants, was run by the Group in collaboration with the South African Institution of Chemical Engineers. The course was given by an authority on the subject, Dr T Allen of Bradford University in the UK.

A major contract job was undertaken on the dewatering of coal slurry from a planned hydraulic transport line. The centrifugal dewatering of slurries of fine coal from five collieries was investigated. It was found that, depending on composition, the slurries which were considered to be a waste product, can be dewatered to such an extent that utilization becomes more and more attractive as the price of fuel rises.

Progress was made with a study on flow patterns in a hydrocyclone with the objective of improving the classification efficiency as required in wet milling circuits (e.g. in ore processing).

Flocculation

The separation of suspended solids from liquids as encountered in the mining and process industries is assisted by flocculation of the suspended fine particles. The Group studies certain fundamental aspects of the mechanism of flocculation. Good progress was made with the development of measuring techniques for these studies.

The concept of selective flocculation was demonstrated on mixtures of cassiterite and quartz; for this purpose a cassiterite-specific flocculant was prepared. In the application of selective flocculation to ores, it will be necessary to give as extensive attention to pretreatment and conditioning as in ore flotation. It was found that ion exchange of pure quartz increases by heat treatment and addition of Al^{3+} (as an example of an impurity).

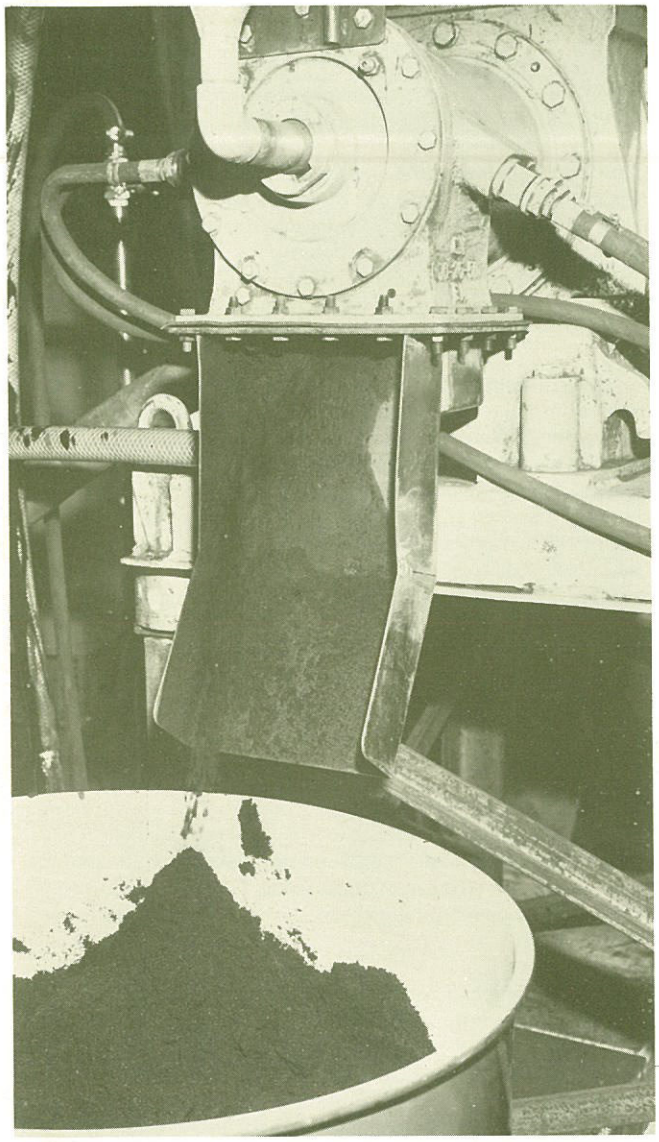
Heat exchangers

The Group develops computer programs for the design of heat exchangers utilized in the process industries. This development of computer design programs is backed up by theoretical investigations aimed at improvements in programmed design and by experimental investigations in fields where insufficient design information is available.

A particularly noteworthy development for computer-aided design of heat exchangers was the establishment of a general equation for the calculation of mean temperature difference in various types of flow configurations.

Fundamental studies

The studies undertaken in this field aim at a better understanding of the transfer phenomena encountered in many practical applications.



A stream of fine coal particles derived from the centrifugal dewatering of a coal slurry.

A final report was prepared on transfer in a packed bed of spheres in which particular attention was given to the effect of packing geometry. For practical applications the skewed cubic packing was found to give the best ratio of transfer to pressure drop.

From a scientific point of view an important finding was that pressure drop in the various packing geometries could be related to a new variable quantifying the voidage distribution in a packing and comprising the number and severity of the expansions and contractions in the flow path. Application of this new variable for flow through arbitrary and anisotropic porous media was recommended.

An electrochemical analogue was utilized for transfer studies. Use of this convenient analogue of local heat or mass transfer at a surface depends on the availability of accurate data on the diffusion coefficient of ferricyanide in carrier electrolyte solutions. A reliable method for the determination of this diffusion coefficient was established.

APRG

air pollution research

AIR POLLUTION RESEARCH GROUP

Head - DR E C HALLIDAY

The Air Pollution Research Group (APRG) is mainly concerned with studying the physical behaviour of pollutants from the time they are emitted into the atmosphere until they are deposited or absorbed on the ground, and with the chemical nature and abundance of the various pollutants in the atmosphere of city and industrial environments. The information obtained from these studies is of considerable value in the effective control of pollution in South African cities.

A combined gas chromatograph/mass spectrometer apparatus used for the identification of gaseous organic pollutants in city air.

Dissipation of pollutants

A study was undertaken of the behaviour of the plume from the NATREF refinery near Sasolburg, making use of photography of the plume, wind recording and temperature sounding, by radio telemetry, to obtain measurements of atmospheric stability. This information was processed in a newly acquired computer and a paper has been prepared for publication in an international journal.

Ventilation potential

Further progress was made on measurements of temperature gradient in the atmosphere and of atmospheric circulation associated with conditions of considerable atmospheric stability. On the basis of these measurements recommendations were made concerning suitable areas for the siting of industries in the neighbourhood of Ladysmith and Colenso, and in the case of Newcastle a recommendation was made that any activity producing emissions to the atmosphere should not be contemplated in the area north-west of the town.

As a result of the quite considerable amount of measurement work which has been done in different regions of South Africa, the Group is now in a position to make reasonably accurate assessments of the ventilation potential of industrial and residential regions of the country and has on various occasions been asked to act in a consultative capacity on the questions of determining site suitability for industrial and residential development.

National survey of smoke and sulphur dioxide

The number of local authorities which are now co-operating in the national survey of smoke has risen to nineteen, seven of which are measuring sulphur dioxide. Since the Department of Health decided to subsidise the local authorities in purchasing measuring apparatus, the Group has not only been increasingly occupied with consultation services to the officials responsible for the measurements in the different cities and towns but also with checking the performance of the apparatus and the adequacy of technicians doing the measurements.

Pollutants from city street traffic

There are now two mobile laboratories measuring the pollutants originating from the exhausts of motor vehicles, and they are operating in all the principal cities of South Africa for periods of one to two months each year. Concentrations are found to be on the low side of the range of values reported from American and European cities.

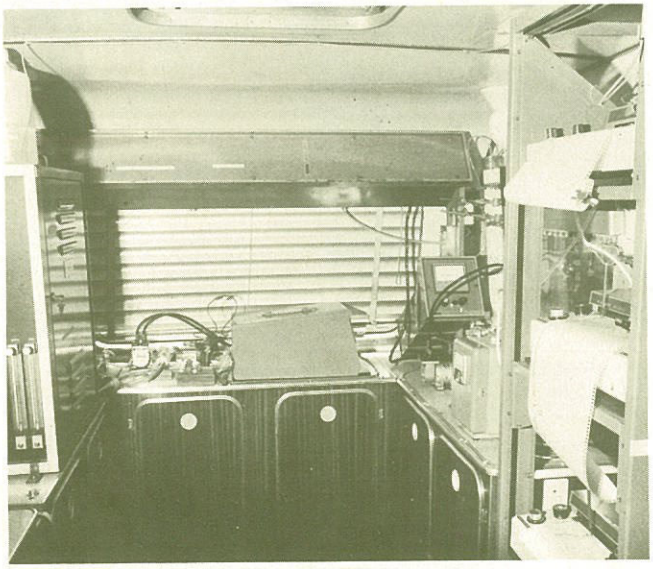
Identification of gaseous organic pollutants

A study has been started on the identification and measurement of gaseous organic pollutants occurring in the air of South African city and industrial environments.

A mass spectrometer linked with a gas chromatograph is now in regular operation and information on gaseous organic substances is being accumulated. Although a number of pollutants which are known to be the precursors of the Los Angeles type of photochemical smog have been identified, it appears that they are still present in too low concentrations to produce any large-scale photochemical reactions. Also, no unexpected substances have thus far been found in the city air samples.

Determination of trace metals

It is known that trace metals such as lead, mercury, nickel, cadmium, iron, chromium, copper and manganese which largely result from industrial activities are undesirable elements. A survey programme has been started to determine the concentrations of these elements in different city and industrial environments, as well as in areas which have been zoned for large industrial development such as Saldanha Bay and Richards Bay. The information obtained from this study will be valuable not only in assessing the present situation but also in determining long-term trends in the concentration levels of these trace metals.



Interior of a mobile laboratory used for monitoring pollution from traffic in city streets.

NBRI

NATIONAL BUILDING RESEARCH INSTITUTE

Director - DR T L WEBB

building research

The wide-ranging activities of the National Building Research Institute (NBRI) affect the lives of virtually everyone in South Africa as the Institute is continuously closely involved in all aspects of the built environment.

The NBRI's own applied research and a continuing close liaison with overseas organizations helps make the best use of the country's resources and the R3 000 million — some 17 per cent of our gross domestic product — spent annually on building and civil engineering.

The industry itself is becoming increasingly aware of the cost-effective benefits of the NBRI's expertise and for the first time commissioned contract consultancy work worth more than R1 million annually. This enabled the NBRI to earn over 40 per cent of its running expenses.

However, the Institute's total costs are still under 0,1 per cent of the annual turnover of an industry which increasingly relies on the NBRI to keep abreast of world technological developments.

The range of the NBRI's activities has continued to increase during the year with the growing awareness of the need to tailor buildings to their functional roles. Industry, government and the general public are also making increasing use of the NBRI to help them to take advantage of new techniques, materials and expertise.

National and regional committees

The NBRI's work is guided by the Building Research Advisory Committee representing the building industry, universities and other public and private sectors. There are now also regional sub-committees for the NBRI offices in Durban, Cape Town, Windhoek and the new centre for the Eastern Cape in Port Elizabeth.

The regional offices maintain close contact with the industry, professions, municipal authorities and public in their areas. Each undertakes special research on particular local problems, such as corrosion on the Natal coast, condensation inside homes in the Cape Peninsula, or being able to use locally available materials for building in South West Africa.

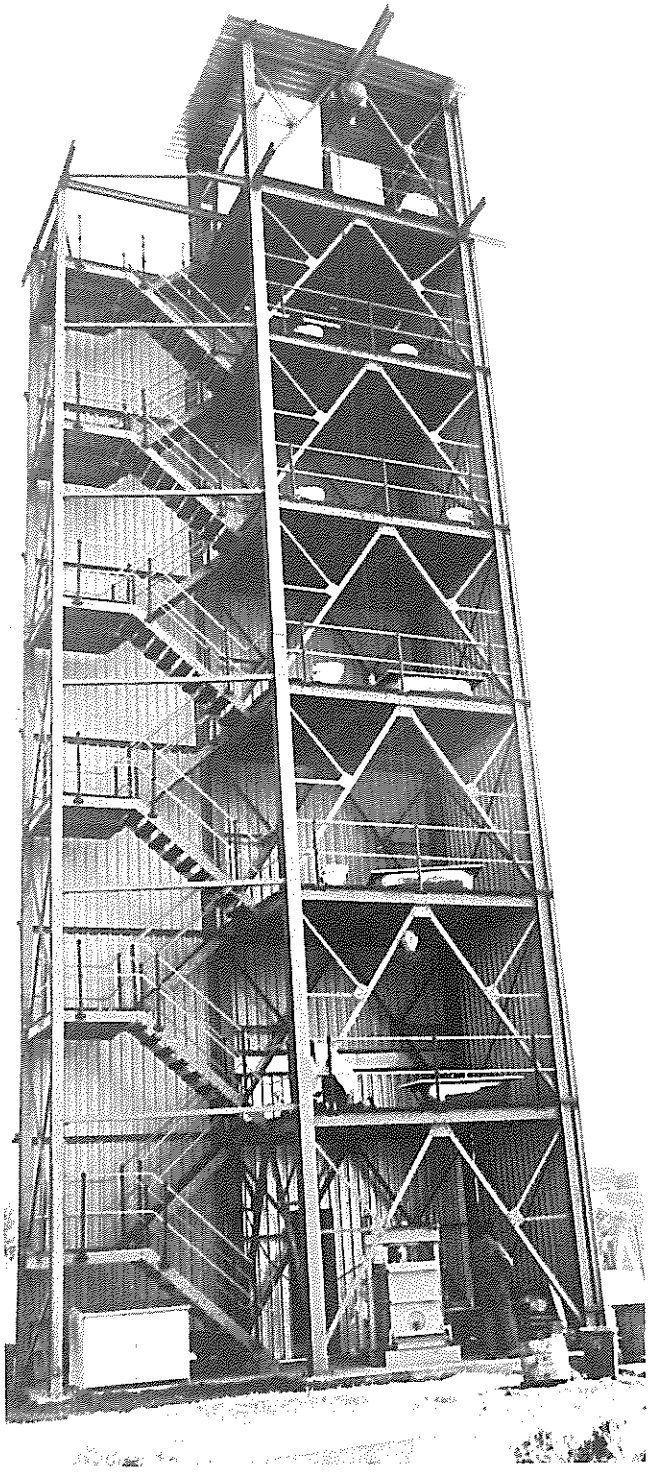
International links

The NBRI's international activities contribute substantially to its effectiveness. It is a member of 26 international organizations involved in building research. During the year members of staff made 19 overseas study tours.

The regular visits by overseas experts have proved also to have considerable practical value in the continuing interchange of ideas and knowledge. For example, the visit of a British group which included experts in guttering manufacture coincided with investigation into the failure of a large number of plastic gutters in Ladysmith following a hailstorm. The visitors' experience and advice led to changes in the design and specification of plastic guttering manufactured in South Africa, and prompted long-term tests into the weathering characteristics of South African plastic guttering.

Better schools

Future generations of schoolchildren will benefit from continuing research projects to develop improved design specifications for schools. Thousands of South African schoolchildren have been measured and boys were found on average to be 22 mm taller than their fathers were at the same age, with the girls as much as 39 mm taller than their mothers used to be. Today's children tend to be lighter despite their extra height.



This test tower which was recently erected on the CSIR test site in Pretoria is used for research on plumbing and drainage services in high-rise buildings.

These facts have contributed to the NBRI's development of a completely new range of school furniture and a new approach to the rational planning of primary schools. The loading space available in the old type of standard primary school is only 45 per cent of the floor area, but can be increased to between 60 and 70 per cent in the NBRI's 'compact planned school'. Standards of environmental comfort have also been formulated for these schools.

Paints and plastics

The closing of the South African Paint Research Institute at the end of 1974 has led to extra demands being made on NBRI expertise in the paint field. The emphasis in research during the past year has been on developing paint systems for timber based entirely on economical emulsion-type coatings. Over 600 sample panels are undergoing exposure tests. A heavy emulsion coating system already developed by the NBRI for a patented roofing product has been adopted in New Zealand.

The Institute has become a member of the International Club for Plastics in Buildings and the Rubber and Plastics Research Association of Britain. A major activity was investigating the fire properties and hazards of plastics materials in buildings. Interesting results are being achieved in the use of plastics for thermal insulation in roofing systems.

Laboratory work into the wear properties and cleanability of soft floor coverings, including carpets, is being linked to a large-scale practical experiment at the H F Verwoerd Hospital in Pretoria and arrangements have been made to install test areas of carpeting at the Pretoria railway station concourse.

Computer progress

The establishment of the Construction Industry Computer Information Centre within the NBRI has been a major step towards bringing the benefits of computer usage within the practical reach of much of the South African construction industry. The Centre operates a national engineering software system which can perform many of the calculations necessary for the design of buildings, bridges, space frames, etc. It should stimulate better building by allowing the engineer to make a more precise choice between alternative designs.

Computer programs of capital works activities are now being used actively in three provinces, and are proving particularly valuable when a key official responsible for capital works leaves and his successor is still settling in.

The CSIR computer has also been used to simulate operating conditions in the frozen food factory which will supply Transvaal hospitals. This has yielded valuable information on how the factory should be equipped and function before even a single brick has been laid.

Eating revolution

In August the NBRI organized the first South African symposium on precooked frozen food, attended by over 200 delegates and 11 overseas expert speakers.

The NBRI has developed suitable systems and the buildings in which to operate them, in addition to guidance on the management aspects of production and distribution of precooked frozen foods. This method of mass-catering for hospitals, factories and other institutions is beginning to revolutionize the eating habits of many South Africans.

A film *Quick meals for hospitals* was produced by the Institute's film unit and premiered at the symposium.

Tower Laboratory

A six-storey plumbing test tower erected on the CSIR test site in Pretoria is the first facility of its kind in Africa.

The plumbing for most high-rise buildings is still specified according to a basically 35-year-old American code because no other suitable data are available. Consequently, most South African high-rise buildings are grossly over-specified in this respect, which represents a serious waste of money, materials and energy. The test tower will help find the answers to many fundamental plumbing problems.

Agrément Board

The NBRI undertakes tests and evaluations as required by the Agrément Board for the issue of certificates for non-traditional building systems, particularly the industrialized building techniques and new materials which can help meet South Africa's anticipated need for three million more houses during the next ten years.

More use of indigenous materials

The year has seen valuable further research into making greater use of indigenous building materials to reduce transport and import costs.

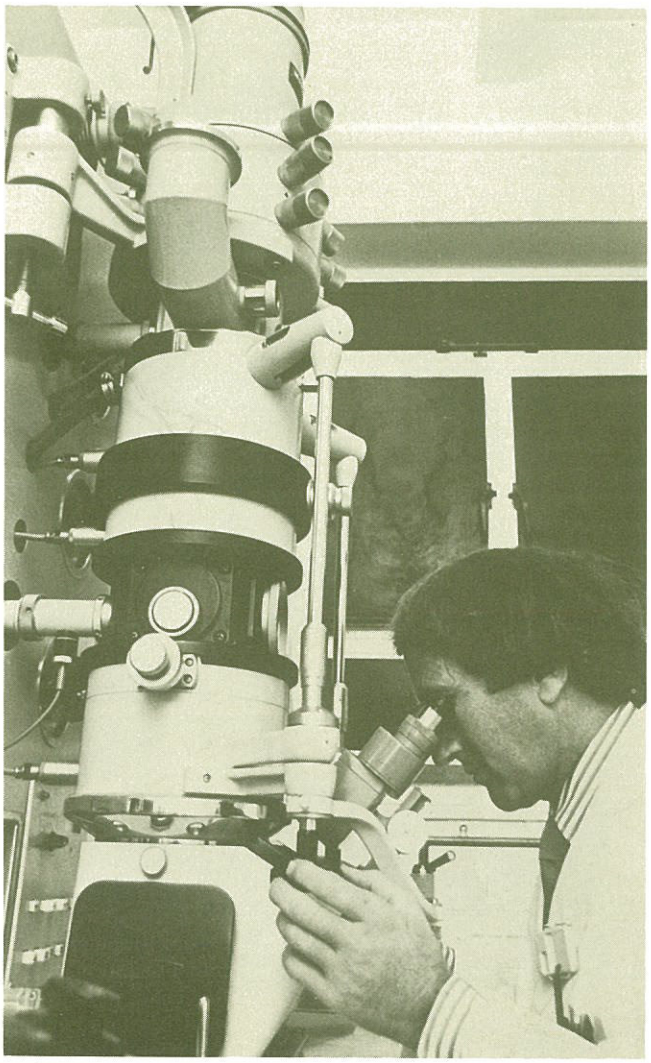
Good progress has been made in investigating how sea and dune sands can be processed to render them suitable for concrete making. Still more information is needed on the properties of concrete made with local materials and the new wing of the NBRI building at Scientiae, Pretoria, is being used as a test bed with devices fixed to the concrete columns to measure their creep rate for comparison with laboratory tests.

Rubber blends

The NBRI's development work on blends of EPDM, SBR and high styrene rubbers has continued to attract international interest and these products promise to have widespread application even beyond the building industry. Also, further work on quick low-temperature curing of rubber blends has been so successful that the South African Inventions Development Corporation is patenting some of the results. The technique enables rubber profiles to be extruded and vulcanized at a fraction of the capital investment required for traditional methods.

Solar and wind energy

The NBRI is continuing to help local industry in its efforts in this field.



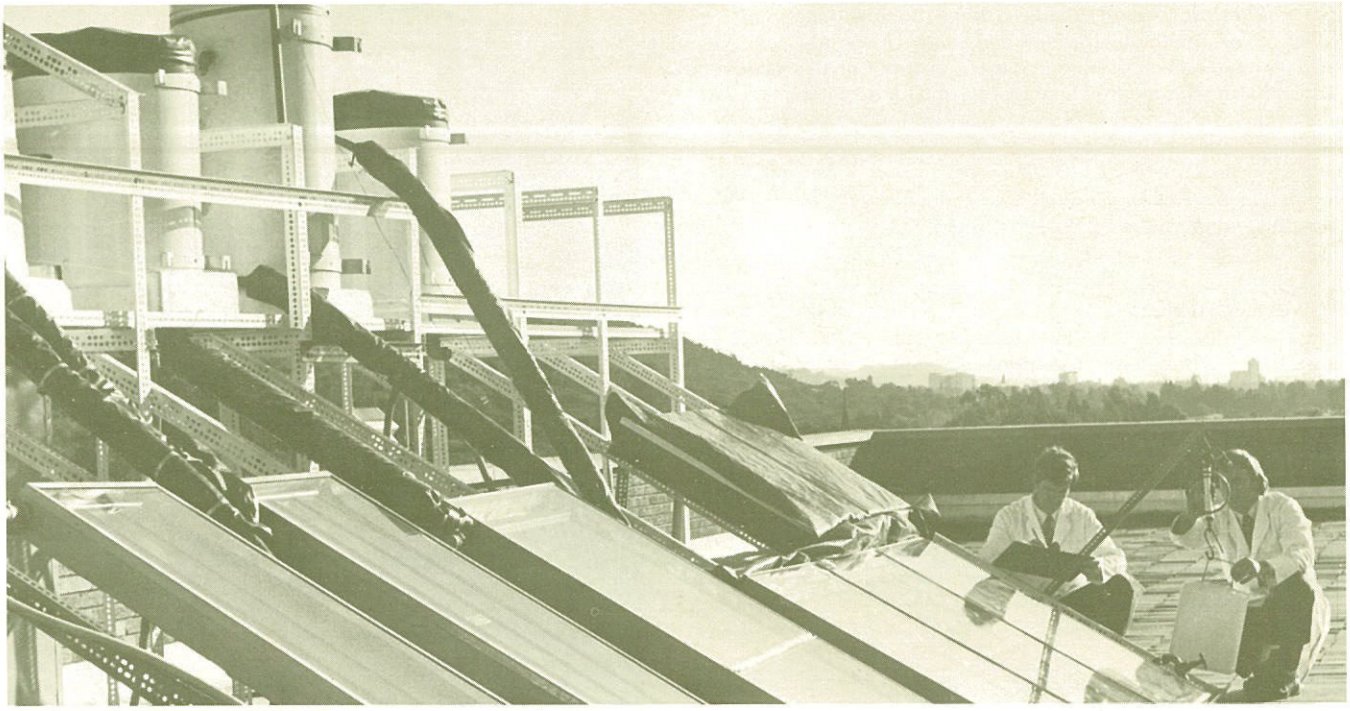
For economic reasons new and alternative building materials have to be found to replace those in short supply or which have to be imported at considerable cost. This electron microscope plays an important role in the BNRI's fundamental research in the field of materials.

Several South African manufacturers submitted solar water heaters for tests and the Institute is collaborating with a commercial firm on the development of a low-cost heater.

Low-cost housing

The NBRI has been asked to undertake further joint investigations with the Department of Bantu Administration and Development into low-cost housing. Universities throughout the country were visited to see how they might collaborate in this project.

An investigation was completed for the Theron Commission on the housing requirements of the Coloured population.



Sales of solar water heaters in South Africa are more than doubling every year and NBRI research on these heaters has also increased. Solar water heaters manufactured in South Africa are seen here undergoing performance tests.

Fire investigations

The Institute's new fire test facility has been improved and investigations continue into the fire properties of various building materials and components, such as lightweight walls, ceilings, wall finish materials and carpets. Several manufacturers have been helped to improve the behaviour of their products in fires.

Brick-veneer housing

Brick-veneer housing — in which a single-thickness outer skin of brickwork is used as cladding round a lightweight, e.g. timber, structural frame — is not common in South Africa, although it is very popular in Australia and Canada.

The Institute has undertaken research into this type of housing and a detailed technical guide is being published which will outline the advantages and disadvantages of this form of construction.

Health and comfort

The first major investigation in South Africa into environmental requirements for human comfort, health and productivity in industrial buildings has been started by the NBRI with part-sponsorship from the Department of Labour.

The wide temperature range in parts of South Africa contributes to low productivity and high accident rates in some factories and there is a further waste of the country's natural resources in trying to overcome this problem by the artificial heating and cooling of unsatisfactory buildings.

A mobile laboratory has been equipped to visit factories during a 6 000 km tour covering the extreme climatic conditions found in South Africa. Temperature conditions inside 25 selected factories in different centres are also being monitored for a year.

The project is being assisted by experts from Israel and Sweden.

Sharing information

The demand for information by the building industry, the general public, government departments and other public and private sectors continues to grow steadily. This has stimulated further preparatory work on developing a computerized data bank for the building and construction industry.

The Institute has continued its efforts to promote the introduction of national uniform building regulations and to get education and training in the building industry on to a more uniform national basis. A guide on good house construction is being prepared for building society inspectors. Increased use has been made of the general interest media to disseminate information about the NBRI and the results of its research activities.

A series of seminars for 300 building society inspectors was held in Pretoria and will be repeated at other venues. The National Safety Glazing Council, on which the NBRI is represented, was established during the year and the NBRI assisted the Council in staging public seminars and preparing an information film.

The symposium on building in the Cape coincided with the first major building exhibition to be held in Cape Town. The NBRI also organized the first international conference in Africa on tall buildings.

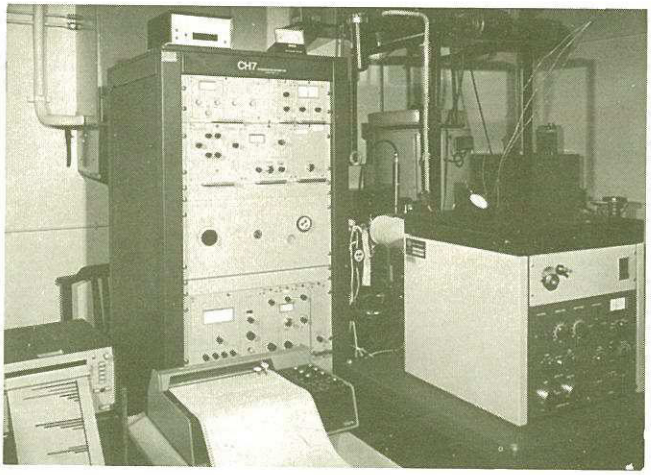
NIWR

water research

NATIONAL INSTITUTE FOR WATER RESEARCH

Director - DR G G CILLIE

Water research is vital in a country like South Africa with its relatively scarce sources of water. The National Institute for Water Research (NIWR) therefore strives to develop expertise on the efficient use and conservation of available resources. Its activities include investigation of the purification of water prior to use, treatment of effluent after use to meet specific standards, and the investigation of specific types of pollution in dams, rivers, estuaries and even the sea. The Institute has a total personnel of 213 and is divided into a number of research groups and regional laboratories. While the regional laboratories at Durban, Bellville, Bloemfontein and Windhoek concentrate on local water problems, research groups in Pretoria undertake basic and applied research on a broad spectrum of problems concerning the optimum utilization of water. Research groups have been established for freshwater biology, water quality, biological treatment processes, physical-chemical treatment processes and desalination. Yet another group deals with technical enquiries.



The combination gas chromatograph *(right front)* and mass spectrometer used to identify microgram quantities of organic material from the unique mass spectra obtained *(left front)*.

Health aspects of drinking water

An important factor influencing the potability of water supplies is the control of dangerous organic compounds, originating from agriculture, industries or normal domestic usage.

Tap water in Johannesburg and Pretoria contains an average of 10 mg/ℓ (0,001 per cent) of organic impurities, Cape Town's 0,005 per cent and Durban's somewhat less. Of these impurities, 80 to 90 per cent have a molecular mass of more than 1 000 and include such substances as polymers (plastics), humic acids from plant material, proteins and living organisms which are rendered harmless by chlorination. The remaining 10 to 15 per cent, with a molecular mass of less than 500, are the most important, as this group includes carcinogens, pesticides and other toxic substances.

Representative water samples are monitored regularly in order to establish which of the internationally known toxic or hazardous substances are present and in what quantities they occur. Until now, these substances have been found to occur well within the limits regarded as safe.

All organic material in the water is systematically extracted and identified with the aid of the method combining gas chromatography and mass spectrometry. The gas chromatograph separates the extract into pure compounds and the mass spectrometer draws 'fingerprints', called mass spectra, of these small amounts of material (often less than one millionth of a

gram). These are used to identify the compounds. Compounds already identified include hydrocarbons (petroleum products), DDT and dieldrin (very small amounts), PCB and dibutyl phthalate (additives to plastics) and organic acids (from plants).

One water sample often contains more than a hundred different components, making identification difficult and time-consuming. Safety profiles are therefore obtained for each sample by means of thin layer and gas chromatography. The profiles are compared, increases in impurities are immediately detected and action is taken, should these increases be hazardous to health. This technique is particularly useful for assessing the efficiency of water reclamation processes in removing the last traces of organic residues.

Results have indicated that these processes can be relied upon to produce a better quality water than present urban supplies.

Ozonation of reclaimed water

Efficient and economic disinfection is a basic requirement for the reclamation of drinking water from sewage. At the Stander Water Reclamation Plant, developed by the NIWR at Daspoort, Pretoria, chlorine is used for this purpose. One of the disadvantages of chlorine is its readiness to react with nitrogenous compounds, especially ammonia. Absolute disinfection is guaranteed only at breakpoint chlorination, in which one part of ammonia nitrogen requires ten parts of chlorine. An alternative disinfectant is ozone, which does not react with ammonia at ozone dosage levels used for disinfection purposes.

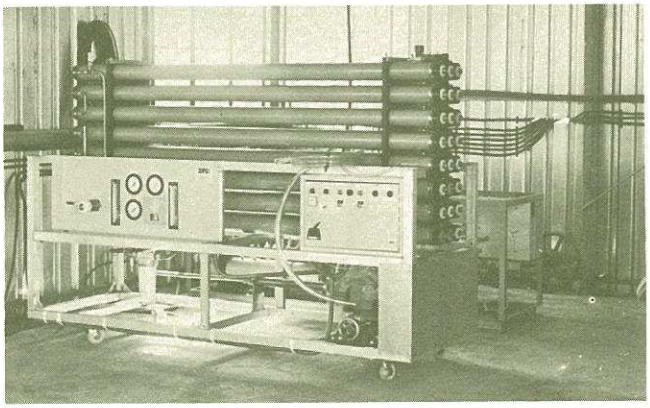
Pilot plant disinfection studies on reclaimed water inoculated with *Pseudomonas aeruginosa* indicated that ozone was four times as effective as chlorine, based on dosage levels, and about seven times more effective according to actual consumption levels. Another advantage of ozone is that it is a highly efficient chemical oxidant. Laboratory studies on the ozonation of selected pesticides and detergents illustrate the potential of ozone for oxidizing chemically-resistant organics.

Because chlorination is generally still cheaper than ozonation, disinfection costs may be reduced by a treatment sequence consisting of ozonation, activated carbon filtration and final application of sufficient chlorine to maintain disinfection in the distribution network. Since ozone has no residual effect, the traces of nitrogenous compounds present in the water after carbon filtration may serve a useful purpose by combining with chlorine to form chloramines, which are more stable than free chlorine and maintain disinfection of the water over an extended period of time.

LFB process

Since the early sixties, extensive research in South Africa has been directed towards the renovation of secondary treated sewage effluents from trickling filters. Although a great deal of success has been achieved at both the Windhoek and Daspoort water reclamation plants, practical feasibility is dependent on low levels of ammonia nitrogen to permit efficient control of breakpoint chlorination. Improved biological treatment techniques for the removal of both nitrogen and phosphorus have been developed by the NIWR and are being incorporated in new sewage treatment plants.

The LFB process is based on chemical pre-treatment of raw or primary clarified sewage with lime, followed by biological processes and further physical-chemical treatment. The stage shown here is biological treatment which follows chemical pre-treatment.



Part of the reverse osmosis pilot plant established in the Beaufort West district.

Another new development involves the integration of sewage treatment and water reclamation. Municipal sewage sometimes contains appreciable quantities of industrial effluents which may adversely affect the biological purification systems. The LFB process (Lime Flotation Biological process) is based on chemical pre-treatment of raw or primary clarified sewage with lime, followed by biological processes and further physical-chemical treatment. The lime flotation process has been found most suitable as a primary stage where most of the organic substances in the form of suspended solids are removed in a relatively small unit (40 minutes retention), thus minimizing the load on the biological processes. This chemical pre-treatment system also removes toxic contaminants, phosphorus and pathogens. Smaller, more reliable biological reactors can then be used with subsequent savings in overall treatment costs.

Several alternative operating methods of the LFB process for nitrogen removal are being investigated. One approach is to utilize the floated organic matter, after alkaline hydrolysis, as a supplementary carbon source for denitrification purposes. A series arrangement of flotation, ammonia stripping and nitrification is also being studied, which will ensure acceptable levels of total nitrogen, mainly as nitrates, in the final product without having to resort to denitrification.

The results obtained in a 100 kℓ/d pilot plant at Daspoort indicate that integration of proven chemical and biological techniques can produce a purified effluent or water measuring up to any desired degree of purity.

Water supply for Saldanha Bay

It is estimated that the water requirements in the Saldanha Bay area will increase from the present 4,6 million kilolitres to 16,7 million kilolitres per annum by 1980 as a result of expanding industrial activity. In collaboration with the Department of Water Affairs, the NIWR investigated methods to meet this increased demand.

A weir is under construction across the Berg River at Misverstand. Water abstracted from this point will be purified and piped to the Saldanha area. The installations, which will be completed by 1978, will eventually have a capacity of 29,2 million kilolitres per annum, if the Berg River flow is supplemented by releases of stored water from the Voëlvlei Dam. Investigations by the NIWR have established that the water can be satisfactorily treated by means of conventional alum flocculation. A process design, based on these studies, has been completed and submitted to the Department of Water Affairs.

The water in the Berg River at Misverstand is a mixture of good quality low salinity water derived from the mountainous upper reaches of its catchment and of high salinity water, originating in the highly mineralized soils in the lower and middle catchment areas. As a result of the increasing diversion of good quality water from upper catchment tributaries of the Berg River into the Voëlvlei Dam and other storage schemes, the salinity of the water in the river will increase and there is a strong possibility that water from the river will require additional treatment in future. This problem may be overcome by desalination of water in the lower Berg River. The NIWR is investigating various promising desalination methods.

Desalination trials in Beaufort West

By the turn of the century, industrial and economic growth in South Africa is likely to be inhibited, since supplies of good quality, low salinity water are limited. Even now fresh water is scarce in some of the more arid parts of the country.

The NIWR, under contract to the Water Research Commission, has initiated a programme to evaluate the various commercially available methods for the desalination of surface and groundwater, which, although fairly plentiful in certain areas, is not suitable for domestic or industrial use because of its high salinity.

Until recently, the only practical desalination processes available have been distillation and, within certain salinity limits, ion exchange and electrodialysis. A new technology known as reverse osmosis (RO) has been developed and is receiving ever-increasing support. As the name implies, this method depends on the reversal of the natural process of osmosis, which is the driving force that causes low salinity water to pass through a semi-permeable membrane to a highly saline water on the other side. In practice, if a suitable membrane, usually made of cellulose acetate or nylon, is supported to withstand pressures of 2 000 to 4 000 kPa, fresh water will pass through it. The original salt content of the saline feed water will be reduced by 90 to 99 per cent and more than 75 per cent of the feed can be recovered.

A pilot plant with a total capacity of 73 kℓ per day has been established in the Beaufort West district to evaluate five RO units with different membrane materials and physical configurations over a period of 12 to 18 months. The units are being used to treat a difficult borehole water with a total dissolved solids concentration of approximately 4 000 mg/ℓ. Recovery is about 70 per cent and salts in the product water are reduced to less than 500 mg/ℓ.

NIRR

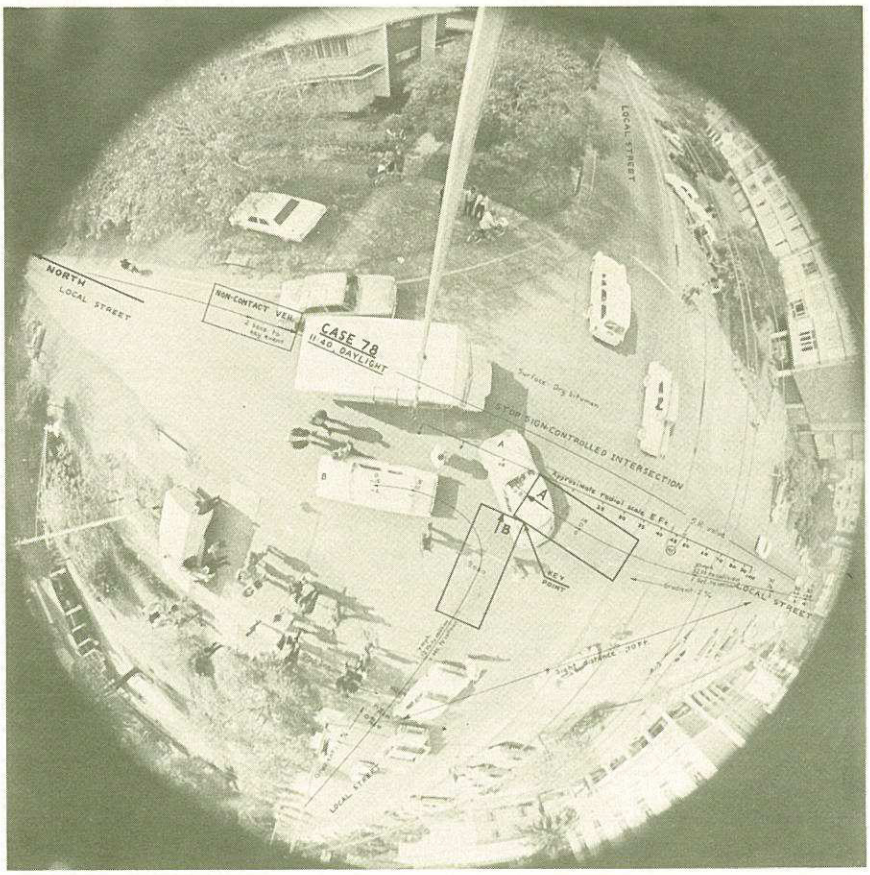
road research

NATIONAL INSTITUTE FOR ROAD RESEARCH

Director - DR S H KÜHN

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

The NIRR works in close collaboration with national and provincial road authorities, the South West Africa Administration, the South African Railways, the National Road Safety Council and the road industry, which together provide most of the funds for road research. The Rhodesian Ministry of Roads and Road Traffic is also affiliated to the Institute and makes an annual contribution to research costs.

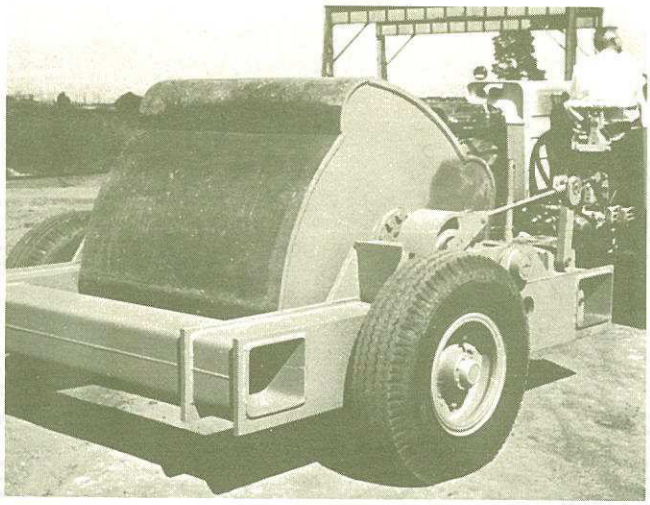


A typical 180° photograph of an accident scene used by the NIRR's accident case study team to investigate the circumstances leading to accidents.

Development of impact roller

Impact compaction, known to be one of the most efficient means of densifying soil, has been long awaited by road engineers the world over, but perhaps particularly so in Southern Africa. The first impact roller was constructed in the fifties by an engineer in the employment of the Cape Provincial Administration, but for many years the problem of reducing the fluctuating load on the drawbar between the roller and the tractor outweighed the roller's undoubted advantages as a compactor. In 1968 the knowledge gained on the project, the patents and the right to continue working on it passed to the CSIR. The complex challenges in civil and mechanical engineering, which full development of this roller presented, were taken up by a multidisciplinary team at the NIRR, working in conjunction with various firms and authorities. As a result, a very effective equalising system was developed for reducing the fluctuating loads. This paved the way for the production of a commercially viable model.

The CSIR impact roller has four faces and is filled with concrete. It has a mass of 10 000 kg and is towed by a wheeled tractor at a recommended operating speed of 8 to 12 km/h. Its compactive effort is derived from the energy of the mass falling from the corners to the faces and is many times greater than that obtained from its static mass. The new equalising system allows the mass to fall unrestrained and even assists it through the impact phase so



The four-sided impact roller developed by the NIRR.

that all potential vertical energy is imparted to the ground. It also allows the mass to be pulled with a positive, reasonably constant tractive effort. The roller is contained within a steel frame fitted with the equalising system and carrier wheels, which normally carry only the frame. By operating hydraulic rams the mass can be raised free of the ground and carried on these wheels to pass over culverts, bridges and finished works, which would otherwise be damaged by the high-energy impact blows.

The impact roller was originally developed to provide an economic and effective means of compacting collapsing sands from the surface, a task for which it has proved eminently suitable. However, engineering trials have shown impact rollers to be applicable to compaction of a far wider range of soils than was originally envisaged, including cohesive granular material. In-depth compaction means that traditionally specified 150 mm layers can be replaced by 300 to 500 mm layers on cohesive soils and up to 1,5 m on sands. With these thicker layers, boulders can be included in fills.

Another example of the versatility of the impact roller is its application to the compaction of Kalahari sands. Construction on these fine-grained, free-draining sands has always been a problem in the past. Their natural moisture content is 2 to 3 per cent but their optimum for compaction is nearer 5 per cent; this creates difficulties as the sands occur in areas where water is not easily available. Current practice is to excavate, increase the moisture content, replace and compact the material in thin layers by conventional means: a satisfactory but expensive method. By comparison, impact rolling has achieved excellent density results, to a depth as great as 4 m, by surface compaction without excavation, at the *in situ* moisture content.

Now that it is possible to compact fills and sub-grade materials to greater depths than before, new questions arise which require investigation. It will be necessary to know, for example, the depths of compaction most advantageous for different designs, as well as the actual density requirements and the cost of obtaining them relative to the life of the pavements. There is no doubt, however, that in-depth compaction can be considerably more economical than conventional methods, and the impact roller will rapidly become an essential part of the road contractor's range of compaction equipment.

Road accident case studies

For several years the NIRR has maintained a mobile accident case-study team for on-the-spot investigations of road accidents immediately after their occurrence. The objective is to identify the underlying factors contributing to all types of road accidents; factors which are not always revealed by the normal police or insurance enquiries.

During the year under review, with the full co-operation of the South African Police and city traffic police, the investigation of 150 traffic accidents in Durban and its environs was completed and the team moved on to Cape Town. The studies in Cape Town and its vicinity are now also nearing completion and appear to confirm the findings in Durban and those from 226 accidents investigated in Pretoria.

- It was found, for instance, that in more than one in three accidents at least one of the participants was driving too fast for the conditions prevailing at the time; this does not necessarily mean he was exceeding the speed limit.
- As regards operating a vehicle in emergency situations a high proportion of failures in vigilance, perception, manipulation and operating skill indicated that a considerable number of drivers do not have the necessary ability to deal effectively with an emergency situation.
- Alcohol consumption was a contributory factor in a considerable number of the cases investigated, particularly those occurring during the hours of dusk and darkness. This applied to both drivers and pedestrians.

National Data Bank for Roads

Notable progress was made during the year in improving co-operation at all levels with the provincial road authorities. A committee set up to advise on operational aspects of the Data Bank has done much to improve understanding and liaison between the Bank, the road authorities and the Association of Engineering Geologists. The rate of enquiries received by the Data Bank has doubled over the past year and there are currently about 10 enquiries per month.

With the support of the committee, a new method of classification has been introduced which is more suited to the needs of the materials engineer, and can be more easily interpreted by him than the former geomorphological method. This new classification is based on parent rock, climate and relief. The approach also utilizes a standard list of descriptive terms for land forms. The use of this list in practice has helped, perhaps more than anything else, to encourage the use of the Bank by road authorities because the terms refer to land forms which are readily recognized by materials technicians in the field. Quarry sheets and other road materials information obtained during routine material surveys can now also be stored in the Bank and the provinces are already doing this on a regular basis. The committee is at present working on methods of storing information on construction problems obtained from the authorities or consulting engineers. The possibility of storing geotechnical data obtained during soil surveys for the planning of new townships is being investigated with the Geological Survey.

Studies on pedestrian bridges

South Africa has one of the highest pedestrian accident fatality rates in the world. Most pedestrian accidents occur when pedestrians try to cross a road away from an intersection. The most effective way to reduce these accidents is to separate pedestrians from vehicular traffic. There are two ways of doing this: by providing either pedestrian subways or pedestrian bridges. Pedestrian bridges are generally preferred because subways are more costly and some people are afraid to use them. The NIRR has recently undertaken an investigation into the circumstances under which pedestrian bridges have so far been provided in South Africa.

Fifty-nine pedestrian bridges were studied — 15 in the Transvaal, 24 in the Cape Province and 20 in Natal.

It was found that most pedestrian bridges had been built over freeways or expressways passing through residential or industrial areas. The volumes of pedestrians crossing the road varied from 6 to 3 700 per hour. At 35 of the bridges there were efficient pedestrian barriers but at 6 of them the barriers had been cut near the bridges and some pedestrians were crossing the road at grade. Commercial vehicles sometimes off-loaded passengers on the freeway and these pedestrians used the holes in the barriers to get off the freeway. Where barriers were present and undamaged 100 per cent use was made of the bridges but where there were no barriers the percentage fell as low as 16 per cent. It is therefore strongly recommended that efficient barriers be erected at all pedestrian bridges.

The main finding of this study was that information on pedestrian accidents and pedestrian and traffic volumes is used only to a very limited extent to decide on the need for a pedestrian bridge at a site. Most of the bridges have been built because freeways or expressways pass through residential areas, or cut off access to stations, bus bus stops or schools. Some bridges have been built at sites where traffic and pedestrian flows are relatively low and where it is doubtful if the pedestrian bridges can reduce the pedestrian accident rate. Only two bridges were built at sites with records of high pedestrian accident rates. Since pedestrian bridges are very costly (from R9 000 to R64 000 with an average of R30 000), they should be carefully sited to ensure maximum benefit to road users.

Special consideration should be given to sites:
- with high numbers of pedestrian accidents;
- with a high density uninterrupted traffic flow;
- with a high concentration of pedestrian flow;
- on freeways and expressways with barriers where the crossing points are far apart, and
- where no method other than a bridge is suitable.

Further studies are being made to establish a definite set of guidelines and warrants for pedestrian bridges in South Africa.

Design of pavements for container terminals

After a seven-month study, the NIRR made general recommendations on the structural design of container terminals as well as the access roads, with special reference to a proposed terminal for the harbour at Durban. This work was done under contract for the South African Railways and Harbours.

During an overseas visit the performance of a number of pavements in container terminals abroad was evaluated and from the information obtained, various structural designs were developed. Comparison of these pavement designs was made in terms of functional requirements and total cost, including delay costs arising during installation and whole-life maintenance costs. For the particular requirements of the Durban harbour, an *in situ* concrete pavement is to be constructed for the main crane and stacking areas. On the landward section of the pier a submerged mangrove swamp will cause settlement for about 10 years, so a precast concrete brick pavement, which can be relevelled when necessary, has been recommended. For the access roads in the terminal, a PVC/tar mix surfacing has been recommended.

NITR

NATIONAL INSTITUTE FOR TELECOMMUNICATIONS RESEARCH

Director - R W VICE

telecommunications research

The work of the National Institute for Telecommunications Research (NITR) embraces the study of natural phenomena and their effects on radio waves, as well as the development of radio systems for particular applications.

In October 1975 the Institute with its central laboratories was moved from the grounds of the University of the Witwatersrand, where it had been situated since its inception, to new premises on the site of the old Republic Observatory.

Ionospheric Research

The NITR carries out research into the ionosphere and its effects on the propagation of radio waves. Regular ionospheric observations are made near Johannesburg, at Hermanus and on Marion Island. Airglow is a useful indicator of certain ionospheric processes, and for this reason a programme of airglow observations is carried out at Sutherland, on the grounds of the South African Astronomical Observatory. Bulletins of ionospheric data and predictions of the optimum frequencies for use in short-wave radio communication are issued monthly.

Many of the short-term fluctuations in the ionosphere are caused by particle radiation associated with solar flares. Such effects are well correlated with electromagnetic radiation at decimetric wavelengths, and in order to investigate these effects the Institute has designed and is now building a solar radiometer operating at a wavelength of about 13 cm.

Radiation, propagation and reception of radio waves

In addition to providing routine radio wave propagation predictions the NITR has investigated a number of specific short-wave communication problems, including consideration of the radiating properties of antennas. A computer program is used in the design of short-wave antennas for specific applications, and also to predict the performance of a variety of VHF and UHF antennas.

On behalf of the National Electrical Engineering Research Institute the use of frequencies in the gigahertz range for purposes of animal tracking is being investigated.

The ever-increasing congestion of the radio spectrum and the growing need for wide bandwidths for digital data transmission has led to a move to higher frequencies in the microwave range. The Institute is engaged in the development of a microwave data communications system operating at 8,4 GHz and with an information rate of 8,5 megabits per second. The system will be used to monitor and control experiments remotely, and at the same time the effects of various propagation conditions on the quality of communication will be observed.

The Institute has advised a number of organizations on problems of communication; assistance was given to the Venda Government in the planning of an extensive VHF network.

Measuring rainfall by radar

Research into the use of radar to study clouds and precipitation is carried out at a radar experimental station at Houtkoppen, near Johannesburg. Here a radar system has been specially designed for the measurement of rain over wide areas. It is being used to measure rainfall over a river catchment area as part of a hydrological experiment.

An 8-mm Doppler radar has been designed in order to measure the Doppler spectra of precipitation echoes; from these the speed of fall and hence the distribution of drop sizes can be determined. An extensive analysis of the observations made on storms over the past three years has been carried out. The storms were divided into three classes, namely unicellular, multicellular and squall-line storms. For each class the drop-size distributions were used to determine the radar reflectivity, the water content, the median drop diameter, and the rainfall rate. The results were used to establish empirically the relationships between the rainfall rate and the three other quantities.

Lightning research

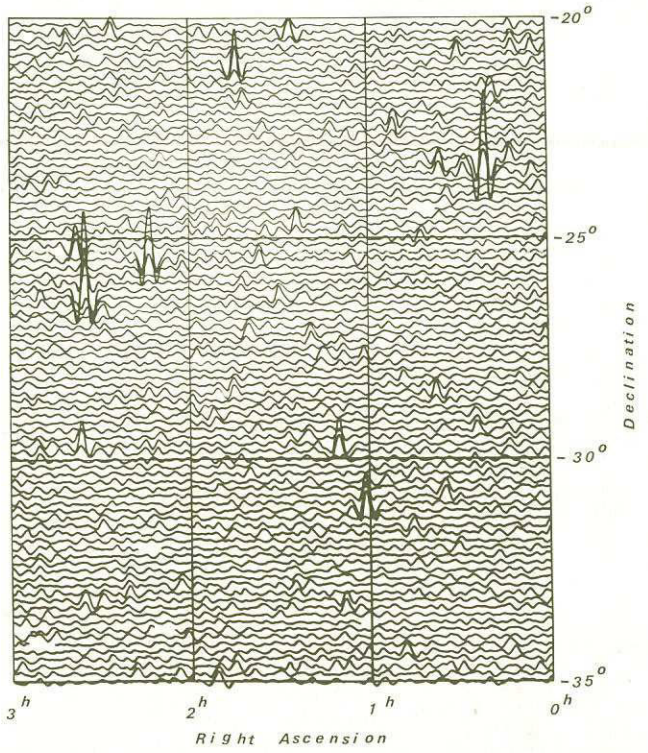
While the visible manifestations of most flashes are obscured by rain and cloud this is not so for the radio waves emitted by lightning. Lightning emits a series of radio pulses whose sources can be located individually by timing the arrival of the pulses at several spaced receivers. By locating a large number of these radio sources it is possible to trace out the paths of lightning flashes with a considerably high degree of accuracy. When this method is used in conjunction with a meteorological radar, it is possible to discover where most of the lightning occurs in relation to the structure of the storm, and in this way something may be learned about the manner in which electricity is generated in thunderclouds. Electric field-change meters are used to measure the quantities of electricity discharged by each flash.

It has been found that most lightning originates several hundred metres above the 0 °C isotherm; many flashes usually discharge to the edges of the precipitation echoes, often tracking the boundaries of the echoing regions as they do so. Another type of cloud flash which gives power pulses begins at the edges of the echoing regions and discharges into the surrounding cloud.

A second project aimed at measuring quantities such as electron density in lightning flashes by means of decimetric radar has been started.

Distance measurement

An important aspect of the NITR's work is the development of electromagnetic systems for the measurement of distance. Since the invention of the 'Tellurometer' system of distance measurement in 1955 the Institute has co-operated with the South African firm which produces this equipment, and as a result of continued research and development South Africa has maintained its position as the foremost supplier of radio distance measuring equipment.



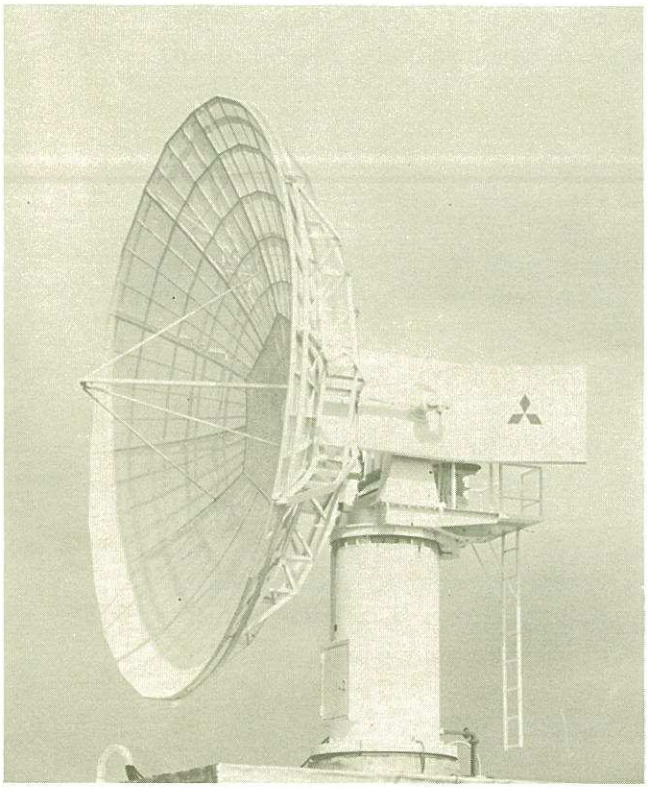
A recording of part of a survey made with the Hartebeesthoek 26 metre radio telescope. The peaks are discrete radio sources lying far beyond the milky way, and associated mostly with galaxies or quasars.

Because of the increasing accuracy of distance measuring systems there has been a need for a standard for their calibration. The Institute, with the co-operation of the Director General of Surveys, has completed the construction of a standard base on a site north of Pretoria. The main section of the base, approximately 864 m long, will be measured early next year by the Finnish Geodetic Institute to within a few tenths of a millimetre.

Radio astronomy

From 1963 to 1974 the NITR carried out a limited programme of radio astronomy at the Radio Space Research Station at Hartebeesthoek, making use of a 26 m parabolic antenna at the Deep Space Station when this was not required for space tracking.

After the closure of the Deep Space Station in June 1974 the antenna became fully available for radio astronomy, and it was decided to develop the facility as a viable radio astronomical observatory. This will allow for the continuation and expansion of the Institute's programme of radio astronomy, and will provide a national facility to which other bodies such as the universities will have access. The new facility will also make the distribution of observatories in the southern hemisphere more complete.



A meteorological radar at the radar experimental station at Houtkoppen, near Johannesburg.

The activity during the past year has been directed mainly at building up the facilities. At present the telescope operates at 2 300 MHz, and is equipped with a travelling-wave maser with a total noise temperature of 30 K and a bandwidth of 20 MHz. Additional radiometers operating at 1 420, 1 665 and 4 500 to 5 000 MHz are being planned. Timing and computing facilities have been installed, and a digital correlator for spectral line observations is being built.

The observing programme, which was disrupted by the closure of the Deep Space Station in 1974, was resumed in February 1975. The survey of variable sources which has been conducted since 1967 is being continued and extended to include weaker sources.

It has been found that the statistical properties of complete samples of intense sources change over time intervals of several years. In order to investigate whether this is true for less intense sources a survey of weak sources in the zone of declination from -4 ° to +4 °, a region surveyed by the Parker Observatory in 1967 and 1968, has been initiated.

Finally, a survey of the zone -45 ° to -60 ° is being made, the observations being co-ordinated with optical observations at the European Southern Observatory in Chile so as to obtain radio observations of an area made within a month of the corresponding optical observations.

Space tracking

On the 31st October, 1975, in accordance with an earlier decision by the United States' National Aeronautics and Space Administration (NASA), the satellite tracking station at Hartebeesthoek ceased operation. The station, one of the worldwide Spacecraft Tracking and Data Network, has been operated there by the Institute on behalf of NASA since 1961.

The station was originally established near Esselen Park in 1958 in order to track scientific satellites as part of the United States space programme in the International Geophysical Year. In 1961, after NASA was formed, it was moved to Hartebeesthoek and enlarged considerably.

In its years of operation the station was noted for its high standards of reliability, and made a valuable contribution to the space programme.

Since April 1974 the Institute has operated a satellite tracking station on behalf of the French Centre National d'Etudes Spatiales.

NIPR

personnel research

NATIONAL INSTITUTE FOR PERSONNEL RESEARCH

Director - D J M VORSTER

The optimum utilization of labour resources is of the utmost importance in South Africa with its acute manpower shortage, especially in respect of skilled labour. The National Institute for Personnel Research (NIPR) therefore devotes considerable attention to this problem, and there is hardly a sector of industry which has not benefited to some extent from its work.

In any work situation there are certain factors directly affecting the worker's productivity and happiness. The NIPR is concerned with the study of these factors, which include:

- definition of the characteristics of work, i.e. description of the job, analysis of the physical and psychological demands made by the job on the worker, evaluation of a specific task in relation to others, and determination of the skills involved in work;
- selecting and placing the right man in the right job (by means of aptitude tests, interests tests, and others), giving him the necessary training, and assessing his performance;
- fitting the job to the man by improving working conditions and equipment;
- studying the socio-psychological aspects of work, e.g. manpower problems, social relations in the work situation, work motivation and attitudes;
- investigation of problems arising from maladjustment to work, e.g. absenteeism, accidents, occupational disorders and group conflicts.

Organization and staffing

The post of Assistant Director was created during the year, and Dr GK Nelson, leader of the Physiological Psychology Programme, was appointed to the position. Dr Nelson has also taken overall responsibility for the Computer and Automation and the Human Adaptation Programmes as well as the Institute's liaison activities.

There has been a tendency for the divisional name, 'Psychology of Learning', to cause confusion, particularly amongst the public, as there has been a shift in emphasis in the Division's programme towards applied industrial training projects. The Division has consequently now been renamed 'Training Studies'. Its tasks have been re-defined and its staff complement increased in order to meet the urgent need for additional research in this important field.

In view of the growing need for the Institute's services in the Western Cape, it has been decided to appoint a full-time member of the NIPR staff to serve at the CSIR Regional Office in Cape Town.

Training needs and personnel practices in industry

A major project concerning the identification of training needs of Black labour in a semi-agricultural, labour intensive and predominantly rural industry was undertaken. The aim was to improve the utilization of manpower by training, in order to meet the growth demands of the future. A training approach previously developed by the NIPR was used, and this was extended to include a job description format whereby training content and training complexity for jobs performed by Blacks could be identified. The information obtained in this way was necessary for making effective training recommendations. The model of the training approach was also amended to allow for the determination of a training strategy, i.e. finding out the most effective way in which a large number of workers throughout an organization or industry could be trained. This aspect has so far frequently been overlooked in the design of training systems, and the fact that the NIPR's model could be adapted to meet the demands of specific situations is proof of its flexibility.

The training project inevitably led to a study of general personnel practices and working conditions in industry. Management and personnel practices were found to vary from company to company, and while the attitudes of management were generally positive and sympathetic towards the Black workers, personnel practices were usually poorly formulated and erratically implemented. These findings emphasize the necessity for the establishment and implementation of well-designed personnel policies.

Licensing of heavy vehicle drivers

During the year a criterion measure specially designed for heavy vehicle drivers was administered experimentally to 900 applicants for driving licences. Routine testing was conducted at nine different municipal centres by licensing officers who had been trained by the NIPR, and to ensure uniformity, special test routes were worked out in advance in consultation with the NIPR.

The criterion measure which consists of right/wrong assessments of behaviour in the yard and on the road, is based on a careful analysis of a heavy vehicle driver's job. It is designed in such a way that discretionary decisions by licensing officers are minimal and assessments focus on small, observable aspects of relevant behaviour.

Analysis of the results indicated that a high degree of uniformity in the issuing of licences could be attained by using this method. It was concluded that the criterion measure could be used nationally, thereby ensuring a uniform standard throughout the country, and a recommendation to this effect has been submitted to the National Road Safety Council.

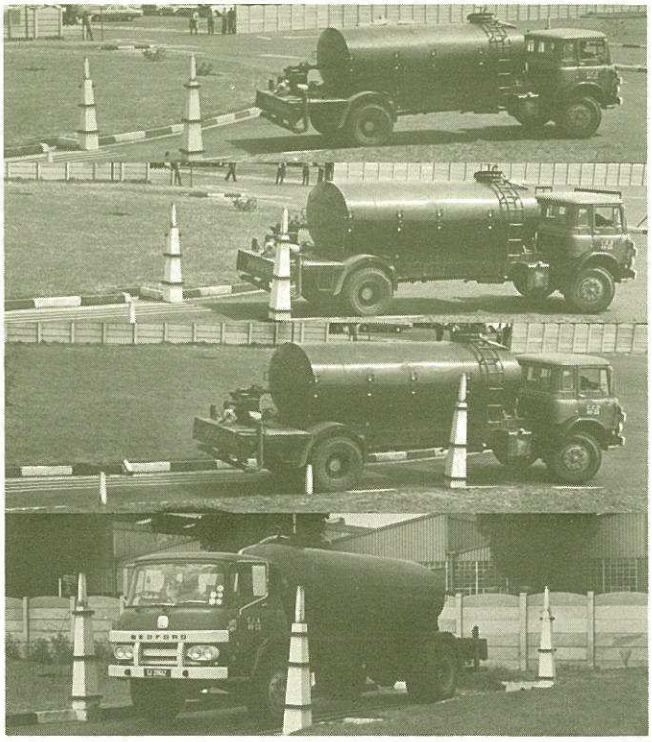
The adaptation of the criterion measure to encompass light vehicles, articulated vehicles and tractors is currently being investigated.

Alcohol and driving proficiency

After a dramatic reduction in road accidents following the introduction of lower speed limits in November 1973 there has been a steady increase in the number of accidents on South African roads. Among the factors seen as possibly contributing to this trend is the impairment of human efficiency associated with alcohol intake. This is no new concept but research has so far been restricted to the relatively short-term effects of drinking, that is to say up to some hours after intake. The question arose concerning the possible persistence of impairment on the morning after an evening of drinking.

In one experiment a number of volunteer drivers were given a series of perceptual and motor tests designed to assess performance on tasks related to driving. These included a simulator in which the testee is required to 'follow' a projected road, with turns and traffic signs, by means of manipulating a steering wheel, brakes, clutch and gear change lever. Because ethyl alcohol exerts a clear effect on brain function, each testee also underwent a brief electroencephalographic examination.

The tests were carried out in the late afternoon. Most of the testees were then given ethyl alcohol in the form of spirits, while a few received non-alcoholic drinks. The tests were repeated about an hour later, after which the testees were given a meal and sent home. On the following morning the tests were given a third time.



A criterion measure for the licensing of heavy vehicle drivers was designed by the NIPR. This series of photographs *(top to bottom)* shows the backing test being done.

As expected there were a number of changes in test performance soon after alcohol. Visual abilities in particular were impaired, as well as performance on the simulator. At this stage blood alcohol concentration was of the order of 0,08 per cent and the EEG showed a predictable change in most cases in the direction of a slowing of the frequency of dominant rhythms.

On the morning after drinking there was slight impairment in respect of reaction time and judgment of time and movement. There was no persistence of impairment in simulator performance. The EEG results supported previous NIPR findings in so far as there were individual differences in the effects of alcohol on brain function. The absence of marked EEG changes at a blood alcohol concentration of 0,08 per cent is striking. On the following morning there was a persistent but very mild depression of brain function reflected in a slightly lower mean frequency of dominant EEG activity. This suggests that while there may be an impairment of brain function on the morning after drinking, this is very slight and varies from one person to another.

Dissemination of research findings

Considerable attention was given during the year to bringing NIPR research and services to the notice of a large number of potential users, especially in other provinces. A newsletter, *NIPR News,* was introduced. It has a fairly large circulation and was well received, judging by the reactions of recipients. Seminars at Port Elizabeth, East London and Durban, presenting the work and services of the Institute, were very well attended and aroused much interest, particularly from industrialists.

More than 800 new test-users registered with the NIPR during this year, and enquiries about improved personnel practices and techniques continued to increase. Routine consultations and enquiries have, in fact, reached such proportions and are taking up so much of the research staff's time that serious attention will have to be given to the setting up of a full-time consultation and information unit to evaluate enquiries, deal with them on the spot, refer them to specialist research staff, or direct them to outside consultants if the work has no research interest.

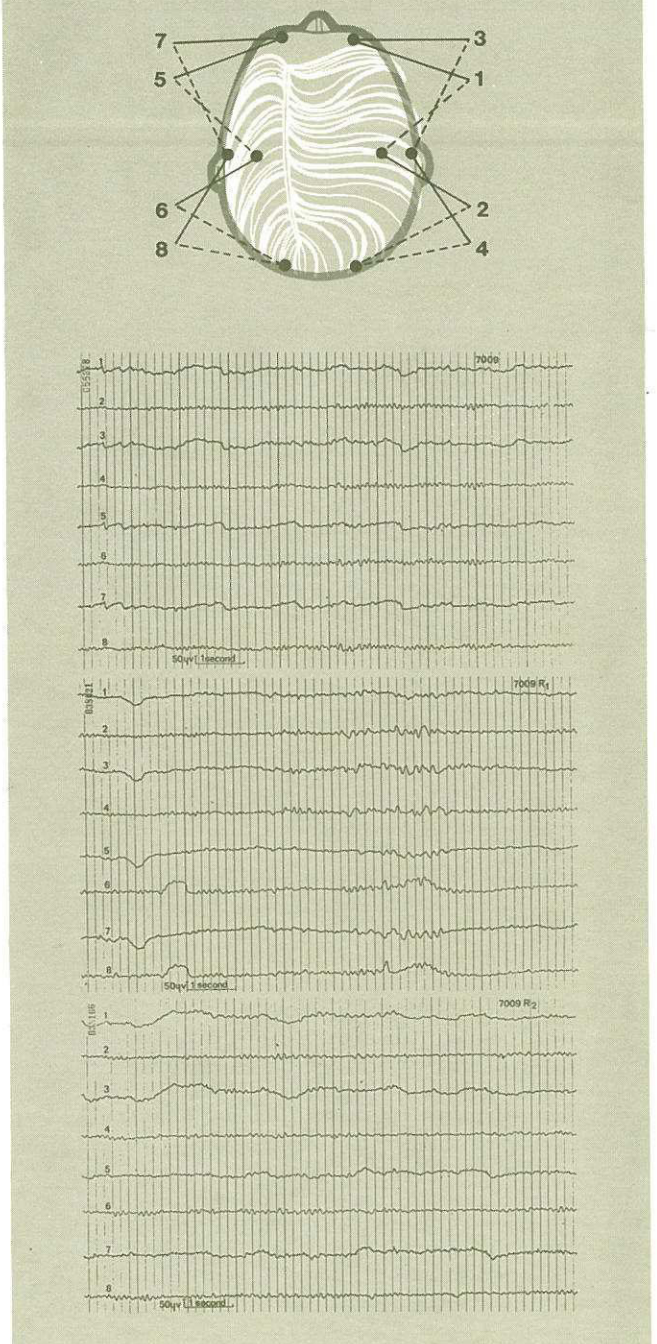
Operational surveys

Diagnostic operational surveys conducted by the NIPR concern the utilization of manpower resources and serve as a basis for re-structuring the personnel management practices of the company involved.

The NIPR has become increasingly involved in assisting organizations to identify and solve labour problems which arise as the result of discrepancies between the expectations of the Black labour force and the needs of management. In one instance, for example, a brief investigation was undertaken to identify causes of labour discontent amongst Black workers in a chemical laboratory. Group discussion and individual interviews were conducted with the workers. White employees involved in their supervision and management were also interviewed. The major conclusions reached were that the negative feelings of the workers were largely caused by lack of communication, poor interpersonal relations, insecurity of workers and inadequate personnel practices. Short and long-term recommendations for improving the situation were made.

Research facilities

A Varian 73 mini-computer was successfully commissioned during the year after a number of initial problems had been overcome. Apart from its extensive use in the neuropsychological field, which was the main reason for its acquisition, there is evidence that it may herald a new era in the psychometric research field of the Institute. A number of fundamental and applied applications of the mini-computer have been formulated in the psychometric research programme and a senior member of staff is studying the latest applications of the mini-computer to psychometric research in the United States.



Alcohol and driving proficiency: Electrical activity recorded from the brain of a 34-year-old man on three separate occasions. Recordings were made from electrodes placed on the scalp in the positions indicated at top. *a.* A recording made before the intake of ethyl alcohol. Normal rhythms, arising chiefly in the posterior areas of the brain, are present. *b.* A recording made shortly after the intake of alcohol, when the subject's blood alcohol content was 0,10 mg/100 ml. Here slowing of the brain's activity is seen in all areas. This may be related to decreased vigilance in the subject. *c.* A recording made about 12 hours after alcohol intake, after a night's sleep. The brain's electrical activity is very similar to that in *a.*, indicating a return to normal.

NFRI

food research

NATIONAL FOOD RESEARCH INSTITUTE

Director - J P DE WIT

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 four research divisions: Food Chemistry, Food Technology, Biological Evaluation and Techno-economics. It also administers and is closely associated with the CSIR Microbiology Research Group and Sorghum Beer Unit.

Typical fields in which both fundamental and applied research is being carried out are food processing, cereal technology, food packaging and storage, flavour chemistry, food microbiology, food analysis, food chemistry and brewing technology. Biological studies of the utilization of nutrients in foods and diets are also undertaken.

Maize research

Research on different aspects of the use of maize was continued with financial support from the Maize Board. An investigation of the starch yield of South African maize from different production areas and extending over three seasons was concluded. In collaboration with the Natal Region of the Department of Agricultural Technical Services the evaluation of the milling and other physical properties of experimental high lysine maize was continued. The nutrient content of the maize was also determined.

The investigation of the production of instant arepa meal by means of modern processing techniques was concluded. The arepa is a kind of maize bread roll, the traditional form in which maize is consumed in certain South American countries. Should this product find acceptance on the South African market, it could contribute to the promotion of the use of maize for human nutrition.

An investigation of the production of citric acid by microbiological conversion of glucose produced from maize according to a process developed in this Institute has progressed to the stage where industrial application is being investigated.

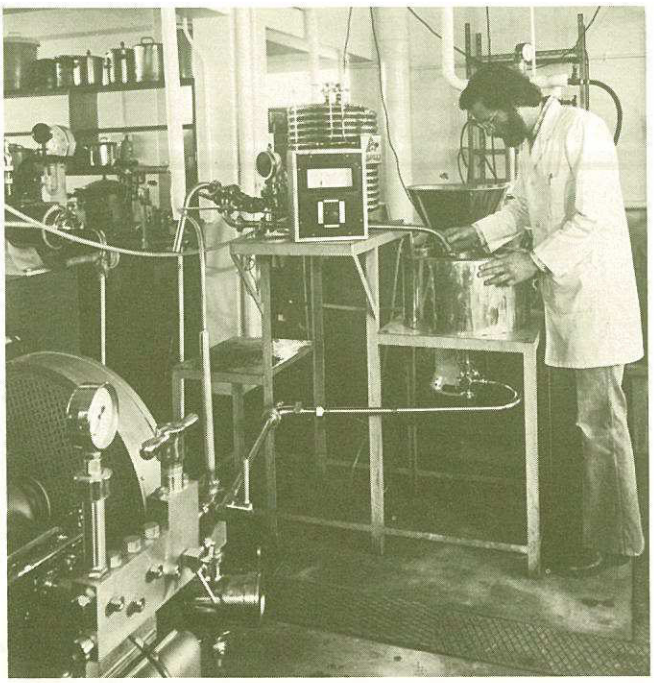
Further research projects include the manufacture of other starch derivatives, such as phosphated starch, which find application in the food industry, and different types of glucose syrups for specific industrial uses.

Utilization of birdproof grain sorghum

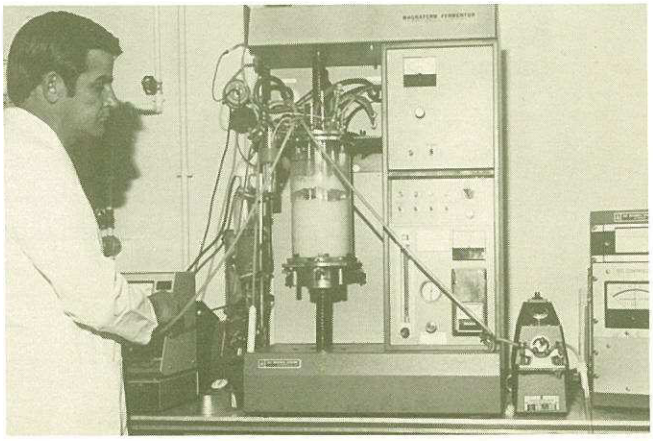
Investigations have been carried out by the Sorghum Beer Unit into the possible use of certain, previously unacceptable, sorghum varieties in the brewing process. These birdproof varieties have been selected by growers for their resistance to bird damage and may be characterized by a dark nucellar layer consisting of polyphenols or tannins. The tannins protect the grain against the ravage of birds, but unfortunately also interfere with the utilization of such grain for brewing, feeding and other purposes. This is because the polyphenols precipitate proteins, including enzymes, by a 'tanning' reaction when the naturally segregated tissues of the grain are mixed, for example during milling.

Research has shown that, in the brewing process, the polyphenols inhibited essential starch degrading enzymes present in malted sorghum, so that sufficient fermentable carbohydrates, necessary for the production of acid and alcohol by bacteria and yeast, are not produced. In addition the polyphenols have been shown to directly inhibit the growth of the necessary bacteria. As a consequence, birdproof varieties, which constitute about one third of the South African grain sorghum crop, had only restricted use. A process developed by the Sorghum Beer Unit results in the neutralization of polyphenols in the intact grain without affecting significantly its physiological properties. This process holds much promise of making birdproof varieties suitable for malting and use in the brewing of sorghum beer.

Concurrent nutritional studies on the digestibility of the protein in grain sorghum using both *in vitro* and experimental animal methods very clearly demonstrated that lowering the polyphenol content or activity by either mechanical or chemical methods has a dramatic improving effect. In some cases the protein digestibility is raised by as much as 35 units on the percentage scale.



Marula juice being pasteurized in the laboratory.



A fermentor used in laboratory investigations into the production of citric acid.

Subtropical fruit

Researchers at the Research Institute for Citrus and Subtropical Fruit of the Department of Agricultural Technical Services observed that the peel of citrus infected with black spot contained a fluorescent compound which was absent in uninfected fruits. At the request of this Institute the compound was investigated by the NFRI, and by making use mainly of mass spectroscopy it was identified as 6,7 dimethoxycoumarin (scoparone), a compound with fungistatic properties. Since the compound has been observed in infected fruits only, its formation is probably a mechanism by which fruits, damaged by black spot, resist infection by fungi.

Also in collaboration with the above-mentioned Institute, a research programme into technological aspects of the processing and utilization of subtropical fruits and other food products has been initiated. Attention is being given to the processing of particularly macadamia nuts, ginger, guavas, pawpaws, mangoes and avocados.

The technological aspects of research into the preparation of marula juice have now been completed. A study of the economic aspects of the production of marula juice is nearing completion and the marketing potential is presently being studied.

Amino acid requirements of the rat

To conclude investigations on the so-called 'essential' amino-acid needs of the rat at different nitrogen balance levels, the optimal 'essential:non-essential' ratios were determined. It was established that also in respect of this ratio the amino acid requirements of the rat are of a varying nature at nitrogen balance levels of less than 100 mg per 100 g body mass per 8 days. The use of the rat as a model in protein evaluation is therefore most appropriate under conditions which will ensure a nitrogen balance level of above 100 mg.

The aim of these studies is the development of a reliable method for the assessment of the biological value of dietary proteins. Current methods may lead to a serious over-estimation of the biological value of certain classes of proteins.

Protein and carbohydrate digestibility determined with aid of rats

The rat is conventionally used as an experimental animal in the determination of the digestibility of foodstuffs. Such determinations are based on what is consumed by the animal as well as on what is excreted in the faeces.

In view of the fact that the rat has a caecum which is, relatively speaking, much larger than that of man, it could be expected that the fermentation, which usually takes place on a large scale in the caecum, will have a greater effect on the degradation of undigested food residues in the rat than in man; and that, where this degradation leads to gas formation, digestibility determinations with rats will yield higher values than those obtained in the case of man.

Experiments in which the protein and carbohydrate digestibilities of certain foods were determined with both normal and caecectomized rats have now revealed that carbohydrate digestibility is in fact influenced by surgical removal of the caecum, whilst protein digestibility remains unchanged.

It could therefore be concluded that the existing method for determination of protein digestibility is reliable in this respect, but that in determinations of carbohydrate digestibility caecectomized rats should be used.

Absorption of fluorine from PVM

One of the components of PVM, the protein, vitamin and mineral supplement developed by the NFRI, is deodorized fish meal (fish flour) — a good source of high-quality protein and minerals, also containing fluorine at a relatively high level. It has become a matter of topical interest to find out whether the amount of fluorine that can be absorbed from the recommended dose of PVM exceeds the safe level.

The serum fluorine levels of 24 baboons that had been fed 30 g PVM per animal daily for 17 months were compared with the levels observed in 49 control animals living in their natural habitat in the Kruger National Park. The results did not reveal any significant differences, i.e. an excessive uptake of fluorine from PVM could not be demonstrated.

Role of fibre in diet

Autopsies on baboons that had been kept on a semi-synthetic diet of very low fibre content for 20 months, revealed in a vast majority of the animals a type of colonic inflammation known as typhlitis, which was probably caused by the lack of an adequate quantity of fibre in the diet.

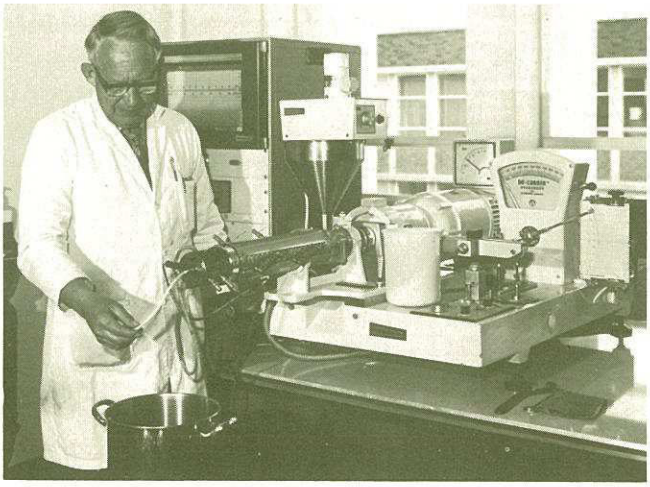
In view of the interest aroused by this observation, experiments are now being conducted to establish the role of fibre deficiency in the causation of intestinal upsets.

Taxonomy of yeasts

The application of micro-organisms in industry for the production of chemicals, feeds and foodstuffs — often from waste materials or by-products — is steadily attaining greater importance. For this reason there is need for a greater understanding of the taxonomy of micro-organisms. The Microbiological Research Group has earned international recognition for its contributions on the taxonomy of yeasts. Currently, investigations are in progress to establish to what extent *in vitro* DNA-DNA hybridization techniques, primarily designed for the study of prokaryotic organisms, find valid application in yeast systematics.

Computerization for analytical instruments

The acquisition of computer facilities has given the Institute a greatly increased potential for the analysis of foods and the study and interpretation of research results.



Experimental preparation of arepa meal from maize by means of extrusion cooking.

With the aid of a dual-disc computer which is directly linked to a combined gas chromatography/mass spectroscopy system the components of highly complex extracts of natural flavours, etc, can be separated, characterized and handled by the computer in one run, with a final printout of results. The computer portion is also available for general work with difficult or tedious tasks, e.g. the evaluation of sensory food studies or the grouping of staphylococcal and micrococcal organisms found in food.

The second computer system can handle the output from a wide variety of instruments (gas chromatography with flame ionization, electron capture and flame photometric detection systems; high speed liquid chromatographs with ultra-violet and spectrofluorometric detector systems; amino acid analysers). The system may be expanded to simultaneously handle data from 32 analytical instruments.

SOUTH AFRICAN WOOL AND TEXTILE RESEARCH INSTITUTE

Director - DR D P VELDSMAN

textile research

The South African Wool and Textile Research Institute in Port Elizabeth, after nearly a quarter of a century, is steadily forging ahead in its programme of research into the processing characteristics of natural fibres, alone or blended with synthetics. A most important feature of the research programme is the imparting of easy-care properties to fabrics where a modern society, with little time to spare for domestic maintenance, demands fabrics capable of being cleansed in a washing machine without the drudgery of special care.

Textile research also aims at more efficient processing of the different fibres which involves the development of existing processing machinery and the design of new machines to achieve these aims.

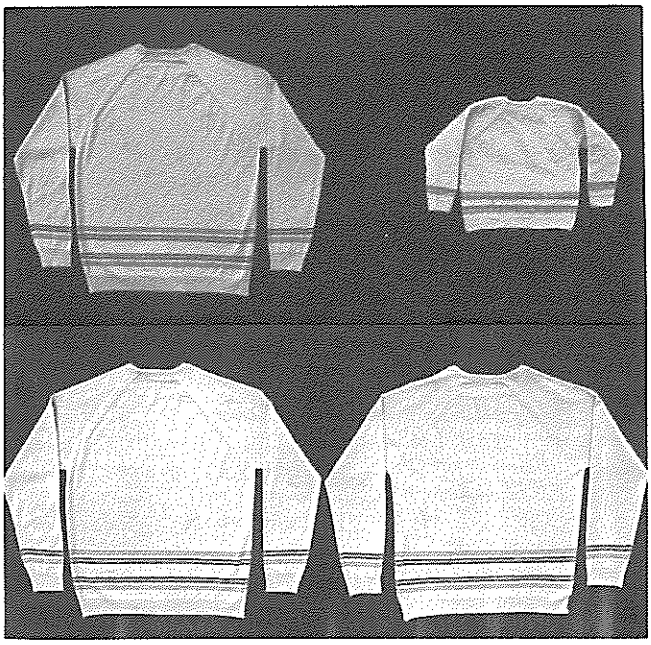
Processing of cotton/wool blends on the cotton system

In last year's report reference was made to the processing of blends of cotton and wool on the worsted system, which involves combing of the fibres. In the light of an increasing demand for blends of fabrics from cotton and wool, such as the well-known Viyella fabric, the blending of these fibres using the cotton system was studied. Throughout the investigation the use of short wool (about 38 mm) together with cotton of comparable fibre length for the spinning of satisfactory blend yarn was aimed at.

From the initial investigation it became clear that carded type wool/cotton yarn containing up to 60 per cent wool could be spun on the cotton system. A wool content of 20 to 40 per cent, however, yielded a yarn which compared very well with standard cotton yarn. It appears from the investigation that too high a wool content should be avoided and that, for the best results, the staple length of the wool should be kept as short and regular as possible. The investigation continues, especially in respect of the determining of the stage at which blending of the cotton and the wool should take place, i.e. in the blowroom, on the cotton card or during the drawing operation.

Processing characteristics of hand picked and machine picked cotton

Cotton production problems associated with the availability of labour have accelerated the development of mechanical harvesting. The introduction of cotton harvesting machines created processing problems and SAWTRI carried out an investigation into the manner in which mechanical picking of cotton affects processing. For this purpose a stand of cotton was picked, one half mechanically and the other by hand. The fibre characteristics of the two lots were compared, after which the processing performance in the blowroom and during carding and spinning was studied; and finally the two yarns that were produced were evaluated.



The top photograph shows an untreated wool garment before washing (left) and after machine washing (right).

The bottom photograph shows the result of successful shrink-resist treatment of wool. A treated wool garment before washing (left) and the same garment after machine washing (right).

It was found that the hand picked cotton contained far less trash and consequently produced less waste than did the cotton which had been picked by machine. Yarns were spun to three counts (15, 25 and 30 tex) from both types of cotton, the hand picked cotton yielding the better yarn in terms of regularity, nep count and yarn strength.

The yarns were subsequently used in weaving tests during which the processing differences up to the yarn stage were not reflected in the weaving performance. In the loomstate, however, the fabrics from the experimental lots of cotton differed only in that the hand picked cotton fabric had a higher tear strength, a lower warp extension at break, a higher weft breaking strength and less trash particles per unit area than the machine picked cotton fabric. After bleaching under identical conditions however, no differences in mechanical properties could be found.

Leno weave in lightweight wool worsted woven fabric

Leno weaving is achieved basically by the crossing over of certain pairs of threads in the warp in certain sequences depending on the pattern desired. Leno has two important functions: reinforcement of the woven structure and achieving high resistance to deformation. When lightweight fabric is woven the construction is fairly loose so that it runs the risk of becoming deformed when worn as a garment. To counteract this deformation of lightweight wool worsted fabric, SAWTRI investigated the use of monofilament synthetic yarn (nylon) in Leno structures incorporated in such lightweight fabric. In accordance with the Woolmark requirements, not more than 5 per cent nylon filament was used. Furthermore, the nylon was visible only on the back of the fabric. The percentage Leno included in the fabric as a stabilizing mechanism varied from 10 per cent to 20 per cent. This resulted in better physical properties of the lightweight wool worsted fabric containing 20 per cent Leno. From the investigation it also became clear that the use of monofilament nylon in the Leno structure is to be recommended as opposed to multifilament nylon for purposes of achieving high resistance to deformation.

Continuous shrink-resist treatment of wool

Surface studies of the wool fibre have already revealed that even chlorination of the fibre during the preparation of wool for shrink-resist treatment is a prerequisite for success. Such a chlorination process developed by SAWTRI and patented by the South African Wool Board ensures that the resin with which the wool is rendered shrink-resistant is spread evenly over the fibre, thus achieving a high measure of shrink resistance.

With the application of this chlorination technique, SAWTRI has succeeded in rendering wool top shrink-resistant in a continuous process by applying an aminoplast together with certain softening agents to the chlorinated wool.

This new process was applied in a local factory, after which the shrink-resist treated top was processed further to fabric. Upon testing the fabric, it was found to be completely shrink-resistant (within only 3 per cent felting shrinkage after stringent washing tests) which conclusively proved that the fabric was completely machine-washable for more than the expected number of domestic washing cycles. The present cost of the chemicals required for the process is estimated to be about 20 cents per kilogram of wool in South Africa. This compares favourably with the cost of other resins currently being used locally for the shrink-resist treatment of wool.

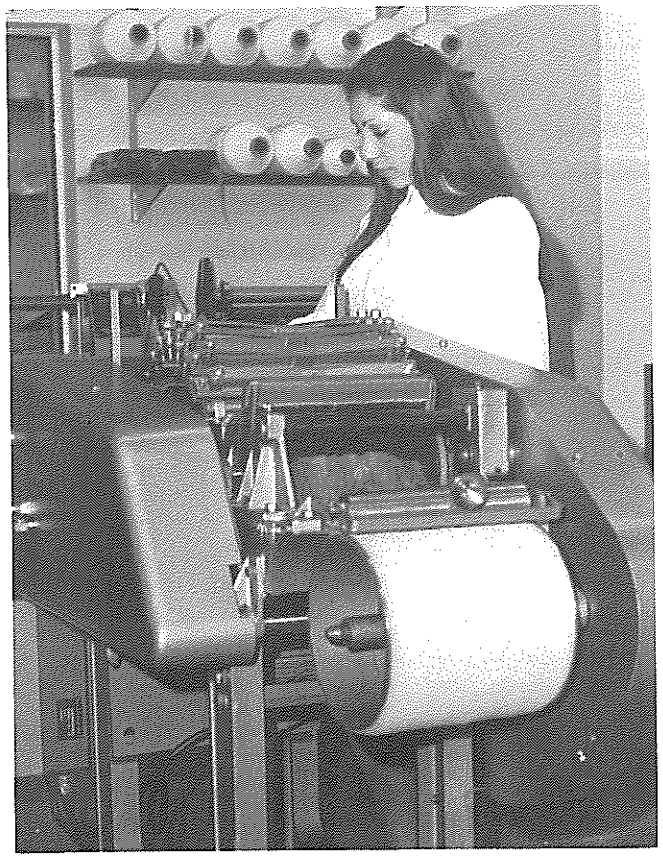
A Buchi solvent dyeing apparatus at SAWTRI.

Solvent dyeing of wool

Much attention has been drawn to the theoretical economic advantages of solvent dyeing systems such as the smaller amounts of water required, less effluent discharge and significant reductions in energy requirements.

Hitherto, industry has not been over-enthusiastic about the application of solvent dyeing techniques but the fuel crisis and stricter control of pollution together with steadily diminishing water supplies have provided renewed research interest in this field, especially as industry will perhaps now take a closer look at what science has to offer in this regard. SAWTRI consequently investigated the possibility of further development of existing knowledge in the solvent dyeing field.

The result was that a laboratory process for dyeing wool with reactive dyes from a charged solvent system, using a single emulsifier, has been developed. The process is based on a simple technique involving the hexadecyl piridinium complex of reactive dyes in perchloroethylene with 40 per cent water and 20 per cent acetic acid, by means of which dyeings of adequate depth, levelness and wet fastness may be achieved, using less liquor and shorter boiling times than are currently employed in industrial aqueous dyeing.



A miniature cotton card — one of a set of laboratory scale cotton processing machines employed in cotton research at SAWTRI.

Low temperature dyeing of mohair

High lustre is a major attribute of the mohair fibre and is one of the reasons for this fibre's popularity as a speciality fibre. Unfortunately, this lustre is adversely affected during certain wet processes such as dyeing. This degradation of lustre is caused by 'yellowing', a characteristic of keratin fibres under certain conditions.

The Institute undertook a study of this problem and has been able to show that yellowing appeared to be more sensitive to time and temperature of treatment than to the acidity of the dye liquid which is usually regarded as the culprit. Dyebath exhaustion, i.e. the amount of dye taken up by the fibre, was also found to be dependent upon temperature. An economic dyeing formula was consequently arrived at involving a temperature of 85 °C (as against 100 °C, as is customary) and the addition of a chemical auxiliary to promote dyestuff absorption as well as lowering the acidity of the dye liquor to increase the affinity of the dyestuffs for mohair. This formula resulted in bright dyeings (i.e. with the retention of lustre) of good colour yield after one hour at 85 °C.

Processing characteristics of South African merino wool

Recent work by SAWTRI on the processing characteristics of the South African merino wool clip accentuating the influence of style, length of staple and class description on processing performance up to the spinning stage has contributed significantly to knowledge in this regard.

It was found that combing performance deteriorated as the style became poorer, fleece wool performing best. Close predictions of the performance of the blends of different types of wool could be made from individual components. The longer wools suffered more fibre breakage during conversion to top. It was also found that there is a significant linear relationship between top and the mean fibre length of the greasy wool.

After statistical analysis of the results of the many experiments carried out, two important relationships regarding mean fibre length of the top and the staple length of the wools investigated were arrived at, i.e. the mean fibre length (in millimetres) of greasy wool was 50 per cent more than the staple length of this wool, which was the same as the mean fibre length of the wool top obtained from it.

These relationships will be of great value to producers and processors.

Extending the investigation to how yarn from the various lots of wool is affected by style, staple length and class description, it could be shown that mixtures of the types of wool investigated in most respects behave as predicted from the behaviour of their components. Deterioration in style within a series of experiments had little effect on spinning performance but often adversely affected the yarn properties. The longer wools generally performed best in spinning and yielded yarn with the best properties.

SAWTRI rotor gill box

The new, revolutionary gill box developed by SAWTRI was the main feature of Messrs Petrie and McNaught, a well-known British firm of textile machinery manufacturers, at the International Exhibition of Textile Machinery, ITMA, in Milan during October. This machine marks a breakthrough in that it is the first entirely South African development in textile machinery. SAWTRI carried out research on and developed the machine during the past number of years and Petrie and McNaught have been given exclusive rights to manufacture and market the machine world wide.

Many unique features are included in the machine, which is designed for high speed operation; delivery speeds of up to 300 metres per minute can be attained without loss of quality.

Phormium research

Decortication of phormium leaves has received much attention at SAWTRI and a significant development has been a new washing process whereby decorticated leaves are carried on a conveyor belt under a set of high power water jets which remove all extraneous material. Decorticating firms have been greatly impressed by the new process especially in view of the recycling of water and the consequent reduction of effluent together with greater conservation of water supplies.

TRU

timber research

TIMBER RESEARCH UNIT

Head - DR D L BOSMAN

The Timber Research Unit (TRU) was established to serve the needs of the wood and wood products sector and the pulp and paper sector of the Republic's forest products industry. As a multidisciplinary, industrially orientated organization, the Unit offers a wide variety of specialized research services to both producers and consumers of forest products. Research and development in timber technology are managed on business principles and the research process is carried beyond the development stage into the field of practical application.

The Unit consists of divisions for timber engineering, wood processing, pulp and paper, timber economics, special projects, and information and liaison services. The aims of the TRU are:

- the effective utilization of South African timber resources
- the development of satisfactory woodbase products
- the development and improvement of manufacturing processes
- the effective use of timber products

Symposium

At a two-day symposium with the theme: 'Getting more out of our timber resources' delegates were told what the Timber Research Unit is doing to help achieve this objective and heard a number of leading producers and consumers of forest products express their views on minimizing waste, waste utilization, using wood and paper more effectively and on the supplementation of wood.

The symposium, which was opened by the Minister of Forestry, received wide publicity in the media and was attended by 155 delegates.

A resolution was passed by the meeting which accepted that there is a developing shortage of wood as a raw material, recognized that there are various inter-related approaches to solving the problem and urged the Forestry Council to make funds available for these purposes.

International meetings

The Head of the Unit attended, by invitation, the second meeting of the newly-founded World Association of Papermaking Research Institutes (WAPRI) and the European Cellulose and Paper (EUCEPA) Conference on the promotion of pulp and paper technology. Both meetings were held in Madrid and the contact established with members of these organizations should be of considerable benefit to TRU research on pulp and paper.

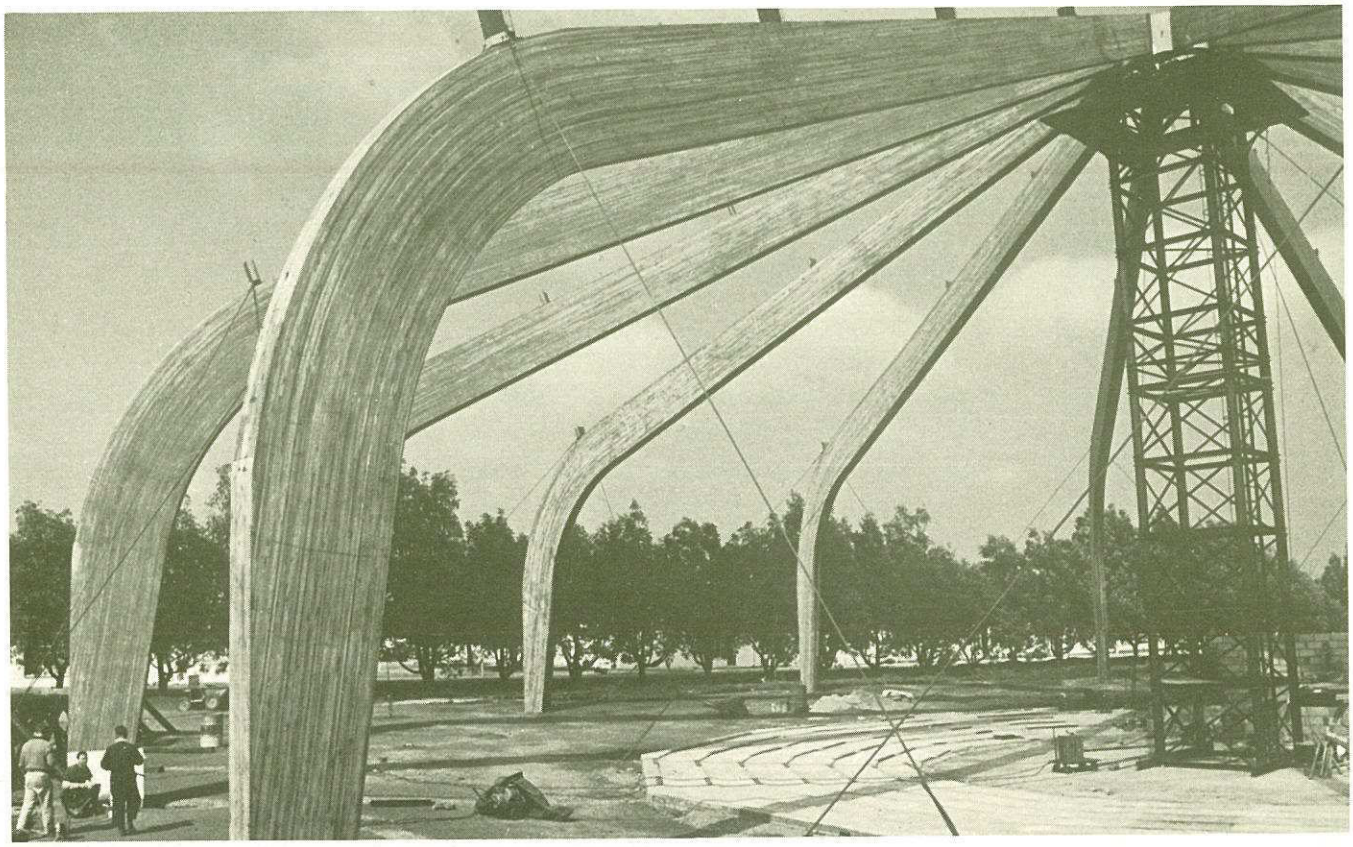
Liaison with organizations and industry

Furthering the policy of devoting more time to direct liaison with the timber industry in the form of personal visits to firms and individuals, the Head of the Information and Liaison Services Division called on timber processors not only in the Pretoria-Reef area, Natal and KwaZulu, but also in Rhodesia and Malawi.

The visits were used to make known and explain the work of the TRU, to determine problems needing attention, to encourage industrialists to make greater use of the facilities and expertise of the Unit and the CSIR, to publicize the symposium on timber resources, and in the case of the African states, to create a communication medium between them and South African scientists.

Semi-hotsetting wattle adhesives

Because of the expense of using resorcinol adhesives in the manufacture of glulam and as a result of the serious shortage of resorcinol which developed during 1974, research was undertaken to develop wattle-based adhesives which could replace resorcinol.



Work on the strength of glued-laminated timber has made possible the design of structures such as this 50-m span church roof near Benoni, Transvaal.

Formulations containing only small quantities of resorcinol (approximately 3 per cent) were found to be suitable for the manufacture of glulam provided that the glulam beams were heated sufficiently to ensure proper curing of the adhesives (60 °C to 80 °C) and that the relative humidity during heating was kept high enough to prevent the beams from drying. When using this type of adhesive the costs incurred in providing the required heating facilities are justified by the large savings due to the much lower price of these adhesives.

Visual grading of timber

The TRU, in collaboration with the South African Bureau of Standards (SABS), the Department of Forestry and the South African Lumber Millers' Association (SALMA), has devised a Republic-wide experiment to evaluate the strength properties of South African pine structural timber and to devise new and more meaningful visual stress grades. With the co-operation of SALMA and the SABS timber which has been sampled throughout the Republic has arrived at the TRU and is being processed. In addition to recording visual characteristics of each piece of timber with its strength properties, all the timber will be mechanically stress graded so as to provide, for the first time in South Africa, a means of meaningfully comparing the two systems of grading.

Stress wave grading system

A new principle of stress grading based on timing the passage of a stress wave through timber has recently been discovered overseas. Preliminary studies by the TRU on South African pine have been very promising and it is hoped that it will be possible to build laboratory equipment to ascertain how this grading principle can be effectively implemented in a mill processing large volumes of timber.

Toothed-ring connector trusses

Standard design sheets for a wide range of domestic roof trusses using lapped members joined with toothed-ring connectors have been produced. The limiting safe spans for each pitch of trusses designed for both tiled and corrugated sheet roofs were determined from the results of a series of tests on full-scale trusses.

Quality assurance for finger joints

A method of quality assurance which uses a TRU Timber Grader in the destructive bending of regularly sampled finger joints has been adopted by several firms manufacturing stock glulam. With further installation of TRU Timber Graders in the stock glulam industry more plants are likely to apply this simple method of spotting grave manufacturing defects which will enable them to take corrective action at an early stage.

Veneerlam

A feeding device developed for the Unit's veneer peeling and lamination (veneerlam) project can be fitted to conventional plywood presses without requiring expensive modifications to existing equipment. A test run using this device has been conducted in industry and a batch of veneerlam boards measuring 7,5 m x 1,2 m x 36 mm has been manufactured. An interesting side effect of this method is the possibility of producing plywood of any length on conventional short plywood presses.

Detailed cost and marketing studies are presently being conducted.

Pole drying

The kiln drying of poles is a generally accepted practice overseas which can be utilized locally, especially in areas where air-drying takes place over extended periods. It was therefore thought advisable to compare the relative costs of kiln drying and air drying and to carry out preliminary experiments in the TRU laboratory kiln.

A survey revealed that the cost of air drying is slightly lower than the estimated cost of kiln drying, but that kiln drying will be more economical if losses caused by drying defects, insects, fungi, etc. are considered.

A preliminary experiment in the laboratory kiln showed that *Eucalyptus cloeziana* poles can be dried successfully in a reasonable time under carefully controlled conditions.

Curing kiln

In order to ensure the correct temperature and humidity for the curing of the semi-hotsetting wattle adhesives, the TRU has developed a prototype curing kiln measuring 20,5 m x 2 m x 2 m. The kiln has been built from glass reinforced plastic and heating equipment and a humidity control device have been installed.

Adhesive extruder

As a result of information obtained during an overseas visit by one of the members of the TRU staff, a prototype adhesive extruder has been built. Its eventual introduction into industry will contribute to adhesive economy, cleanliness and increased production in glulam plants.

Timber trend analysis

The TRU continued its survey aimed at detecting discrepancies between supply and demand of softwood sawn timber at an early stage. However, it was decided to replace the postal questionnaires to sawmillers with computerized data obtained from the Timber Marketing Bureau.

Techniques are being developed to forecast the demand of softwood sawn timber on a short-term basis. Some techniques are showing promise but their true value will only be known after a few years.

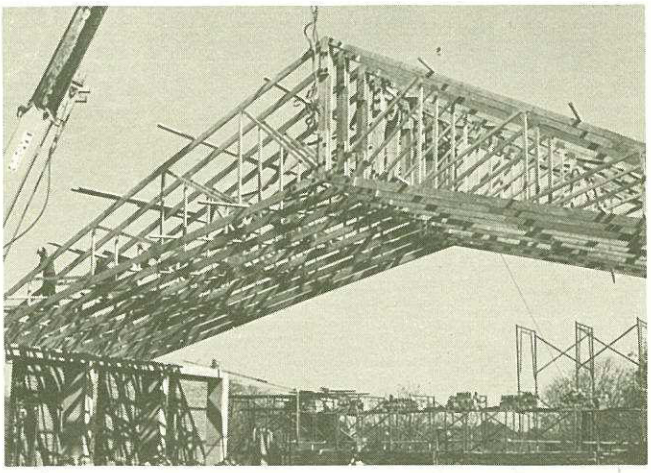
In general it was found that the demand for softwood sawn timber had increased during 1974 compared with 1973 but that the prospects for the coming year were not as promising because of the decline in the activities of the building industry.

Sawing patterns

A project aimed at developing optimum sawing patterns for given conditions of log supply, market demand and specific sawing equipment was undertaken.

Sawing patterns were developed by computer simulation techniques and can be optimized for maximum volumetric recovery from the logs or maximum financial return.

The present computer program takes account of the taper in the logs and is at present being tested in an actual sawmill to verify the practicability of the whole system.



The Timber Engineering Division of the TRU has been investigating design methods for timber trusses, such as these 23,9-m span prefabricated nail-plate trusses for a church roof in Pretoria.

Sawmill interfirm comparison

A commencement was made on a sawmill interfirm comparison during the year. In this comparison the production performance standards of some of the largest sawmills are being compared with each other on a trial basis to see where assistance can be given in improving the productivity of sawmills.

Sugar-cane bagasse for pulp and papermaking

The pulping of bagasse by the sulphate, soda and NSSC processes was investigated. From this research it appears that —

- pulping proceeds so rapidly during the initial stages that 95 per cent of the reactions are completed within the first ten minutes at pulping temperature;
- the required residual lignin content should be controlled by manipulation of the chemical charge and pulping temperature and not by lengthening the pulping time;
- the yield of full chemical bagasse pulp is about 50 per cent;
- bagasse has a certain pulp quality potential which is reached regardless of pulping process or pulping conditions. This potential is significantly lower than that of eucalyptus;
- there is hardly any difference in the rate of soda and sulphate pulping, and the difference in strength properties of sulphate, soda and NSSC pulp is negligible. NSSC pulp, however, is more bulky than both soda and sulphate pulp.

TSD

technical services

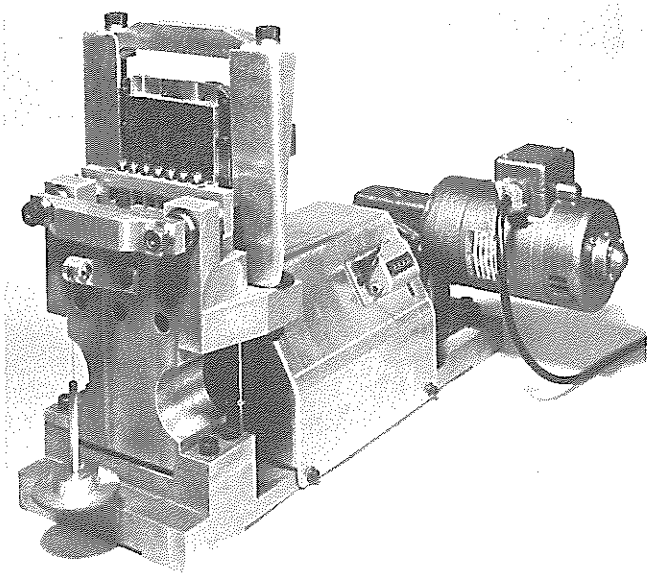
TECHNICAL SERVICES DEPARTMENT

Director - DR T HODGSON

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

The training of instrument-makers forms an important part of the Department's contribution towards industrial development in South Africa.

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



This wear rate tester for powder metallurgical samples is an example of the specialized equipment manufactured for CSIR research institutes by the Technical Services Department.

Services to the CSIR

The Technical Services Department assisted the CSIR's research institutes with the design and/or manufacture of various items of specialized equipment, a few of which are mentioned below:

- rubber extrusion curing unit
- high-temperature, high-pressure autoclave
- fabric appearance monitor (textiles)
- ion source manipulator
- chromosome analyser
- rotating sky camera
- stiffness tester for bituminous bonded road surface materials
- wear rate tester for powder metallurgical specimens.

Investigations, advice and development

Investigations, undertaken on a contract basis, included the following:

- mechanical handling of sorghum beer cartons and crates
- determination of suitability of a numerically controlled lathe for the machining of specific components
- surface texture measurements of shaft journals.

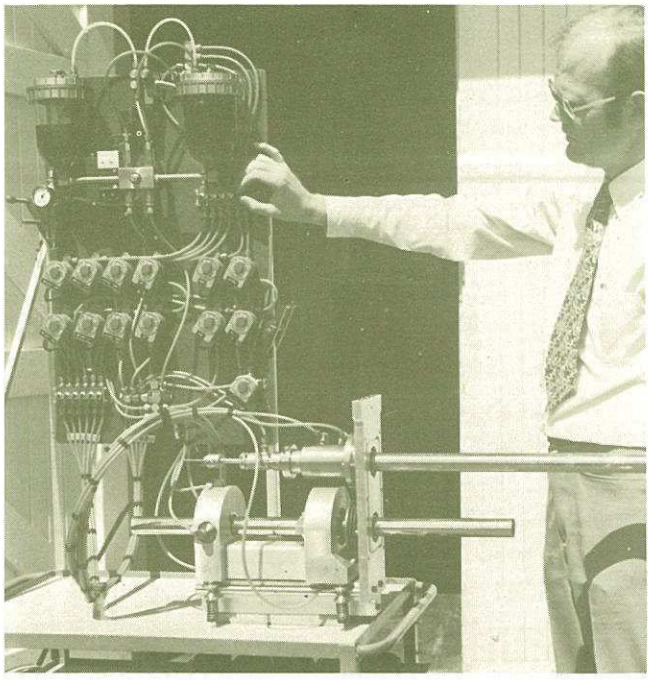
Design and manufacturing

Assistance with the design, development and manufacture of specialized equipment such as the following was provided to industry and to other institutions:

- welding nozzle flame test apparatus
- coil spring winding tool
- wheat extruder
- air glow photometers
- artificial limb adjusting jig.

Production engineering advisory service

A course in programming for numerically controlled machine tools was presented to delegates from industry.



An ion source manipulator manufactured by the Technical Services Department.

Eight basic courses in low cost automation (LCA) were presented, namely five in Pretoria and one each in Durban, Port Elizabeth and Cape Town.

Eight introductory two-day courses in low cost automation were presented to factory personnel at the request of the National Productivity Institute with a view to acquainting manufacturers with the possibilities offered by this technique.

Two seminars on low cost automation were presented at the request of, respectively, the Natal College for Advanced Technical Education and the National Development and Management Foundation.

Further courses in the above fields, as well as additional courses for personnel in the metal manufacturing industry, have been planned for 1976.

Assistance

Practical assistance with the implementation of low cost automation was provided to manufacturers during a series of two-day visits to factories which were arranged in collaboration with the National Productivity Institute. A mobile LCA unit, equipped with simulators and tools for the manufacture of mounting structures for pneumatic devices, is being used for this purpose.

Manufacturers were provided with advice on possible applications of low cost automation in their factories and various automation projects were undertaken under contract.

Facilities

A numerically controlled lathe has been added to the facilities used by the Numerical Control Section to assist CSIR institutes and to train factory personnel for the metal manufacturing industry.

IRS

information and research services

INFORMATION AND RESEARCH SERVICES

Director - D G KINGWILL

The main functions of the CSIR's Information and Research Services (IRS) are —

- ☐ the communication of scientific and technical information
- ☐ the promotion of scientific research in general
- ☐ the promotion of industrial research
- ☐ the representation of South African science.

General

The year 1975 saw two major organizational developments in these services.

Firstly, the greatly expanded activities related to national scientific programmes previously catered for by a division in the Information and Research Services were relegated to a separate unit within the CSIR. The activities of the National Scientific Programmes Unit are reported upon in the following chapter of this report.

Secondly, the Library and related information services — which include the Technical Information Service for Industry, the Documentation Systems Development Service, the South African Selective Dissemination of Information Service, the Foreign Language Service and the South African Water Information Centre — have become part of a Centre for Scientific and Technical Information. This development recognizes the increasing importance of modern scientific and technical information services and the rapid growth of these services and is in conformity with similar developments in other countries. Although the Centre has a separate identity, it is still linked with the Information and Research Services and its activities are therefore reviewed in this chapter.

A view of the current periodicals collection in the CSIR library.

Library services

The successful introduction of specialized information services has brought about a considerable increase in the demand for photocopies and for inter-library loans. Additional funds have been allocated to increase the periodical holdings of the Library to enable it to provide better services at the national level, but the greater part of these will probably be taken up by greatly increased prices of subscriptions.

A microfilm reader in the CSIR library. The reader is capable of providing photocopies of specific pages as required.

Progress in the mechanization of the central Library was somewhat retarded because of staff problems, but this matter is again actively pursued.

Source guides

The fourth edition of the union catalogue *Periodicals in South African Libraries* appeared during the year. Like the third edition, this was issued on microfiche only. The use of COM (Computer Output Microfilm) techniques has proved far more economical than publication in hard copy form, and the number of subscribers is likely to increase as more libraries acquire microfiche reading equipment.

COM techniques are also being used to produce a cumulative index of CSIR publications on microfiche which is available at a nominal charge to interested parties.

Information for industry

There has been steady growth in the demand for the CSIR's current awareness service for industry, and at the end of 1975 there were some 360 subscribers.

A variety of subjects of interest to industry was covered by a series of one-day seminars held in Pretoria, Cape Town, Durban and Port Elizabeth.

The CSIR Automation and Production Technology Service, introduced during the previous year, now provides industrialists with a convenient channel for using appropriate services offered by the CSIR, particularly those involving more than one institute.

Computerized information services

There has been rapid growth in the South African Selective Dissemination of Information Service and at present more than 850 subscribers are served. In addition to the five bibliographical data bases in the field of physical sciences and engineering used at present, the use of data bases covering the social sciences and agriculture are being experimented with in co-operation with appropriate organizations.

Reference, advisory and contract services

The South African Water Information Centre, which was established on contract to the Water Research Commission, became operational during the year.

Contract work on the establishment of a documentation centre for information related to Lake St Lucia and its environs has been completed.

Although the total number of reference service enquiries did not differ markedly from those of the previous year, there was an increase in the number of requests for extensive retrospective literature searches, mainly from industry.

The National Library Advisory Council has requested the CSIR to provide an advisory service in the field of library mechanization as well as a documentation service in the field of librarianship and information science. Unfortunately a shortage of suitably trained staff has delayed the introduction of such services.

New bibliographic services

Good progress is being made with a co-operative project (on behalf of the National Library Advisory Council) aimed at the use by the CSIR Library and other participating libraries of machine readable catalogue information prepared in the USA and the UK.

A start has been made with on-line retrospective searching of bibliographical information, using video screen and typewriter terminals. It is hoped that other organizations will join in this venture, involving the use of terminals to the CSIR computer.

Publications

Three CSIR publications — the *CSIR Annual Report — 1973*, the two-monthly journal *Scientiae* and an illustrated colour brochure dealing with South African activities in Antarctica won awards in the USA during 1975.

In addition to a revised edition of the booklet *CSIR — organization and activities* an illustrated colour brochure entitled *CSIR — research for South Africa* (in English, Afrikaans, German and French versions) was published during the year.

There is a persistent demand for the three directories *Scientific Research Organizations in South Africa*, *Scientific and Technical Societies in South Africa* and *Scientific and Technical Periodicals published in South Africa* as well as for the six-monthly *Calendar of Scientific and Technical Meetings in South Africa*.

The fourth issue of the *South African Journal for Antarctic Research* (which is published on behalf of the South African Scientific Committee for Antarctic Research) appeared during the year and was well received.

The CSIR also acts as the publishing agent for the quarterly review *Scientific Progress* which is issued by the Office of the Scientific Adviser to the Prime Minister.

Textile terminology

Good progress has been made with the preparation of a considerably expanded and revised bilingual dictionary of textile terminology (English-Afrikaans and Afrikaans-English) which it is hoped to publish during 1976. It is expected that this dictionary will contain more than twice the number of terms in the previous edition which was published in 1973.

Publicity services

In addition to the two-monthly popular journal *Scientiae*, various media are used to publicize the work of the CSIR. These include the mass media and the CSIR would like to place on record its appreciation of the co-operation received from representatives of the press, radio and television.

Nearly 50 news releases were issued during the year and good coverage was obtained in the press and radio services, while numerous enquiries from press and radio representatives were handled. In addition radio interviews were arranged with CSIR officials while proposals for programmes featuring science and research were discussed with representatives of SABC-TV.

A documentary film entitled *Two Rivers* was produced in collaboration with the National Institute for Water Research and released towards the end of the year for showing in cinemas throughout the country. In addition, 16-mm copies are being made available to schools, clubs and other groups. Two short news films dealing with the purification and re-use of water were also produced for the public circuit.

Automated slide programmes with pre-recorded commentary, utilizing dual projection, provide an effective and relatively inexpensive means of informing visitors and other groups of the activities of the CSIR. During the year a number of these programmes were made for special occasions.

Interpreting services

An interpreting service of limited extent for conferences and symposia organized by the CSIR is being planned. The primary objective is to provide facilities for simultaneous interpreting from Afrikaans into English for the benefit of overseas participants.

As no facilities for the training of interpreters in the scientific and technical fields exist in South Africa, the CSIR itself will have to institute a training programme. Final selection of candidates for training will be done in collaboration with experts from Europe.

Conference services

In the meantime, the demand for the services offered by the CSIR Conference Division continues to increase. During the year under review some twenty conferences, symposia and seminars were organized in collaboration with or on behalf of professional organizations, organized industry, universities, national laboratories and institutes of the CSIR and international bodies.

In spite of rising costs and an inevitable increase in registration fees, there is a steady growth in attendance at these meetings.

Liaison services

The central Visitors Office of the CSIR annually handles arrangements for some 1 500 visitors. During 1975 these included several high-ranking visitors from overseas, as well as a number of Cabinet members, local members of Parliament and the winners of a competition held in conjunction with the 11th National Youth Science Week.

Major functions for which arrangements were made during the year included a reception on the occasion of the CSIR Council Meeting held in Pietermaritzburg and the opening of the new laboratories of the National Institute for Telecommunications Research in Johannesburg.

Arrangements were also made for CSIR participation in a number of exhibitions including 'employers' days' at some of the major South African universities.

International relations

Activities arising from membership of certain non-governmental international organizations, notably those of the International Council of Scientific Unions (ICSU), included participation in a number of international meetings. The most important of these were the general assemblies of the ICSU unions of Geodesy and Geophysics (Grenoble), Pure and Applied Physics (Munich), Pure and Applied Chemistry (Madrid) and the ICSU Abstracting Board (Brussels).

At a symposium held in Odessa under the sponsorship of ICSU's International Association of Geochemistry and Cosmochemistry, South Africa was represented by the President of the Association, Prof LH Ahrens, who is also the Director of the CSIR's Geochemistry Research Unit at the University of Cape Town.

Another notable event under this heading was the meeting of the Executive Committee of ICSU's Scientific Committee on Oceanic Research (SCOR) in Stellenbosch during November 1975. Hosted by the CSIR, this meeting provided a valuable opportunity to South African oceanographers for discussions with colleagues in other countries.

Overseas offices

The South African Science Offices maintained by the CSIR in Washington, London, Paris and Bonn continue to provide services to South African scientists by making arrangements for official visits abroad, facilitating the exchange of scientific information between South Africa and foreign countries and advising South Africa's diplomatic representatives at the various missions in matters related to science and technology.

A fifth office, attached to the South African Consulate-General in Tehran, was opened during 1975. This Office is headed by Mr GA Harvey, an electrical engineer with considerable experience in the international scientific and technological sphere, who holds the title of Consul (Scientific).

The office in Germany is now well established in the new building of the South African Embassy in Bonn-Bad Godesberg, on the left bank of the Rhine (Auf der Hostert 3).

Towards the end of the year under review both the Washington and London offices moved into new quarters. The former moved out of the Embassy Building in Massachusetts Avenue to the third floor of a building at 2555 M Street NW, Washington DC 20037. The address of the London Office remains unchanged as the move took place within the same building — from the 6th floor to more spacious accommodation on the second floor of Chichester House at 272 High Holborn (London WC1V 7HE).

Industrial research development

Surveys of the activities of the three co-operative Industrial Research Institutes are undertaken at five-yearly intervals by the Group for Techno-economic Studies for the purpose of furnishing the Advisory Committee for the Development of Research for Industry with suitable information on which to base recommendations, *inter alia*, for CSIR financial support for the ensuing five-year period. During 1975 the research programme of the Fishing Industry Research Institute was reviewed. Following recommendations based on a survey of the Leather Industries Research Institute, undertaken during 1974, the technological state of the art and economic possibilities of wattle-based adhesives were further investigated.

The Group for Techno-economic Studies is also engaged in research and liaison concerning the development and application of technology in the industrial development of the country as a whole. Work on the identification of manufacturing ventures suitable for Coloured entrepreneurs supported by the Coloured Development Corporation continued, and for this purpose opinion methods and computer models were used. Contact between the CSIR and the Xhosa Development Corporation was extended through mutual visits by directors of CSIR Institutes and senior staff of the Corporation.

Techno-economic research for manufacturing industry

In June 1975 the need for training in the textile industry was discussed at a conference, organized by the CSIR in collaboration with the industry as a result of a recommendation by the Advisory Committee for the Development of Research for Industry following a techno-economic survey of the textile industry. The conference unanimously recommended the establishment of a national training board for this diversified industry and a continuation committee has been set up under the chairmanship of the President of the CSIR to carry out this recommendation.

A thorough survey of the technological and research needs of the furniture industry was made at the request of the Federation of Furniture, Upholstery and Bedding Manufacturers. This was undertaken as a pilot survey for a project aimed at investigating the technological and research needs of all manufacturing industries on a cyclical basis.

Environmental economics

Growing interest in the economic aspects of pollution and environmental conservation led to a techno-economic investigation into the litter problem in South Africa, which was completed during the year. The published reports of the survey were extensively quoted in the news media, while a final confidential report was prepared for consideration by the Department of Planning and the Environment.

R & D expenditure

Reports on research and development expenditure in South Africa for the financial years 1970-71 and 1971-72 were released early in 1975. Reports on the financial year 1973-74 were submitted to the Committee on Research Expenditure of the Prime Minister's Scientific Advisory Council. The survey on expenditure for the financial year 1975-76 is now in hand. The Group for Techno-economic Studies continues to improve coverage of the private sector by canvassing new respondents. Studies on the extension of the surveys as an aid to the formulation of science policy were also continued and recommendations are being considered.

Support of university research

The CSIR acts as the Government agency for the support of university research and for the award of post-graduate bursaries in science and engineering.

During the year under review the value of bursaries were increased considerably in an effort to encourage candidates to obtain higher qualifications and thus alleviate the shortage of doctoral students in certain disciplines.

A total of 811 grants were awarded during the year.

NSPU

co-operative scientific programmes

NATIONAL SCIENTIFIC PROGRAMMES UNIT

The objectives of the National Scientific Programmes Unit (NSPU) are to provide the services required by the CSIR Executive in identifying and defining problems in South Africa amenable to scientific solution through co-operative national programmes. The scientific co-ordinators, in collaboration with scientists in universities and research organizations, are responsible for defining such scientific programmes and stimulating and co-ordinating contributions within a specific programme. The Unit is required to provide the means required for remaining abreast of all research relevant to existing or planned national programmes and to foster South African participation in international programmes, particularly those sponsored by the International Council of Scientific Unions (ICSU).

The national scientific programmes being carried out by the CSIR are collaborative undertakings of official agencies, universities and laboratories in the private sector in planned programmes, with the object of either contributing to an international programme in which South Africa has agreed to take part, or of achieving, by means of a co-ordinated effort within the country, some scientific objective of special national importance.

These national scientific observation and research programmes are normally associated with international endeavours launched from time to time by ICSU or its member unions, to encourage large-scale co-operative enterprises directed towards the solution of problems of world-wide scientific interest and importance which, on account of their magnitude and complexity, are unlikely to be solved by separate organizations or even nations working alone.

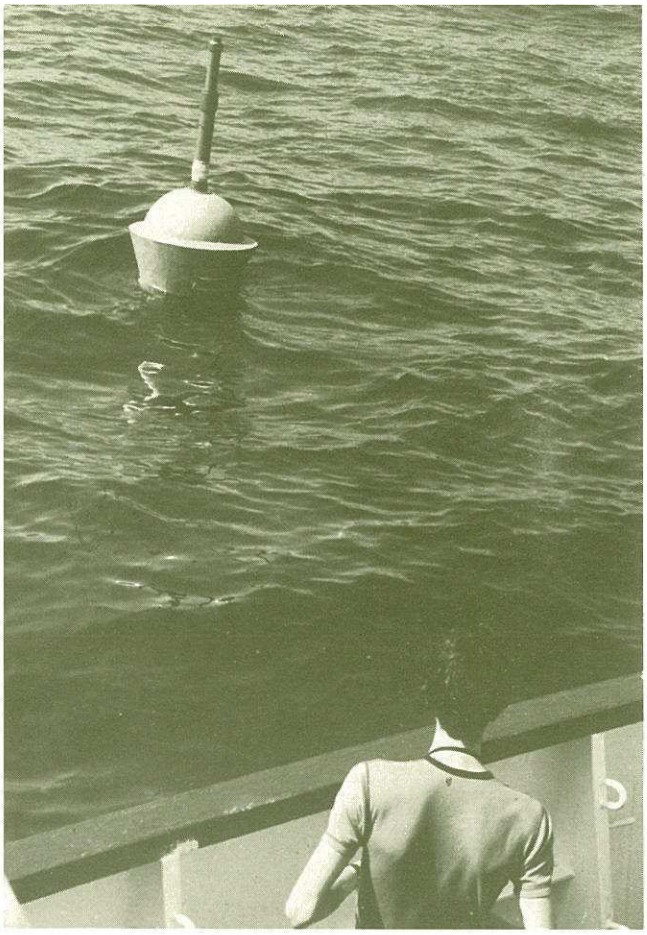
The NSPU, in association with the CSIR's International Relations Division, is responsible for the administration of South African membership of ICSU unions and scientific committees which are related to national scientific programmes.

Earth sciences

The present activities of the Division for Solid Earth Sciences are concerned with the South African contribution to the International Geodynamics Project, a six-year research programme launched in 1973 by the Inter-Union Commission on Geodynamics of the International Council of Scientific Unions (ICSU). In broad terms the objective of the international programme, in which more than forty countries are participating, is to obtain a better insight into the dynamics and dynamic history of the earth, with emphasis on deepseated foundations of certain geological phenomena, such as mountain building, continental drift and the formation of ore deposits.

The National Geodynamics Programme is co-ordinated by the South African Scientific Committee for the International Union of Geological Sciences (SACUGS).

During the past year considerable progress has been made in the intensive multi-disciplinary research undertaken in a number of well-defined narrow strips of terrain crossing the orogenic belts of the Cape, the Damara, Namaqualand, Natal and the Limpopo. Five South African universities, the CSIR and the Geological Survey are participating in this research.



Oceanography: A buoy released in the Agulhas current region east of South Africa starts on a journey aimed at providing meteorological data from areas of the southern oceans from which no information is presently available.

A particularly important project has been the detailed refraction-reflection study of three NE-SW profiles carried out in the Damara Region of South West Africa by a group of scientists from the Bernard Price Institute of Geophysical Research in collaboration with seismologists from three West German universities. The aim of this study is to obtain a quantitative appraisal of the degree of continuity of the crust of the continent at great depth in this geologically less stable mobile earth belt containing zones of strongly deformed rock.

Progress has also been made in the comparative geochemical and geochronological studies on oceanic rocks and those of the Karoo System, with a view to obtaining information on the processes which led to the break-up of the ancient super continent, Gondwanaland, into the present continents of Africa, South America, Australia and Antarctica.

Remote sensing

As a result of the interest created by the South African participation in the American LANDSAT programme, in which satellite imagery of the earth surface was used in various investigations, the CSIR has, with the approval of the Minister of Planning and the Environment, formed a national committee for remote sensing. With the support of interested organizations represented on the committee it will, among other things, identify those national needs where remote sensing techniques could be useful. Furthermore, the committee will pay special attention to encouraging the training of those who will use such data.

Antarctic research

Research at Sanae — the South African base on the Antarctic Continent — and on Marion and Gough islands, is co-ordinated by the South African Scientific Committee for Antarctic Research (SCAR). There are three broad fields of research i.e. the biological sciences, the earth sciences and upper atmosphere physics.

The upper atmosphere physics programme is continuing at an accelerated pace. With the earth sciences programme the stage has been reached where for the next two years a concentrated effort will be made towards a synthesis of all the information gathered to date. When the new relief and research vessel with its helicopters is put into service in 1978, more senior earth scientists will be able to undertake field programmes in the Sanae hinterland during the summer season. Preparations are being made for a number of university departments to be involved in the activities. A full record of the work done to date will serve as the necessary starting-point for the work planned. The biological programme on Marion Island is continuing, and negotiations with a view to establishing closer international co-operation in this field are in progress.

The Scientific Committee for Antarctic Research maintains the closest liaison with the Department of Transport, whose budget makes provision for Antarctic research.

Upper atmosphere physics

The South African programme for upper atmosphere physics in South Africa, Antarctica and on Marion Island is continuing, and is being accelerated and adapted in order to be integrated as efficiently as possible with the International Magnetospheric Study scheduled for 1978 and 1979. Another international project aimed more specifically at the Southern Hemisphere, the Antarctic and Southern Hemisphere Aeronomy Year, will be launched at the same time, and some of the South African projects will be directly integrated with it. South African scientists are closely connected with the planning of certain aspects of these two international projects.

Oceanography

Several research projects are in progress. In addition, attention has been paid to the redefining of the national programmes for physical oceanography and marine biology in the light of the results already gained with the work that was supported by the South African National Committee on Oceanographic Research (SANCOR).

As regards the marine biology programme, attention is being paid to the possibility of having a systems approach to large parts of the programme. The final form of the programme is being worked out together with the participants, and considerable progress in formulating an integrated programme has been made.

Several joint projects in connection with physical oceanography have also reached an advanced stage of planning.

It has been recommended by a sub-committee of SANCOR that the CSIR and the Geological Survey jointly establish a national oceanographic data centre. The details of this undertaking are at present being worked out.

Environmental sciences

The National Programme for Environmental Sciences sets out to identify environmental problems in South Africa which are amenable to solution through research and to co-ordinate co-operative research projects aimed at solving these problems. In terms of these objectives the programme undertakes research into environmental problems in inland waters, terrestrial ecosystems, the sea, the lower atmosphere and in regard to solid wastes.

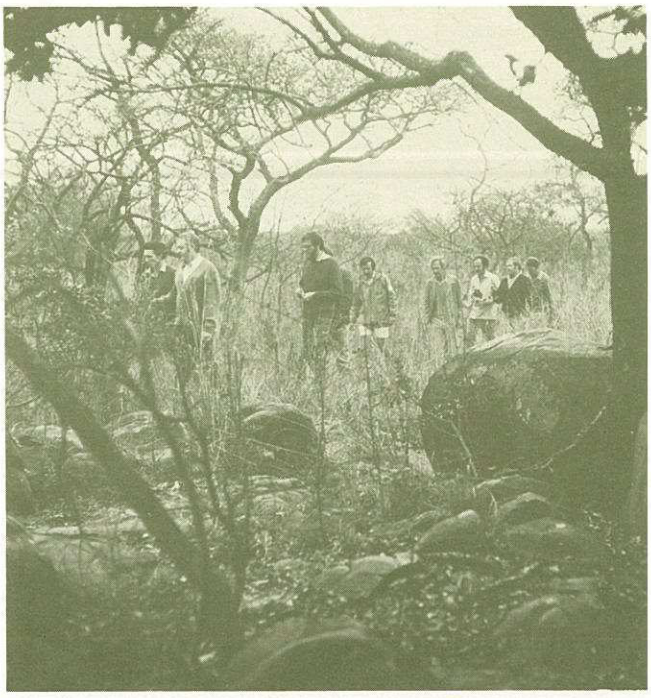
An extensive programme of research into the environmental implications of the Orange River Project has been extended to include studies which will help overcome mineralization problems which would otherwise greatly have hampered irrigation in the Fish and Sunday River areas and studies of biological productivity and the fisheries potential of the Hendrik Verwoerd Dam. This research is of considerable economic significance.

Some coastal lakes in the southern Cape Province and along the coast of KwaZulu have been considerably exposed to the effects of development but others have fortunately been sheltered from development. Research being undertaken into the limnology of these lakes will greatly assist the planning of these regions.

Eutrophication of impoundments has been revealed to be one of the most urgent environmental problems affecting inland waters in South Africa. Important research into the fate of the plant nutrients phosphorus and nitrogen in these waters and into the factors affecting their availability to algae and aquatic weeds is hoped to provide knowledge which will make possible the management of river catchments and the control of weed problems and algae blooms.

Among South Africa's most important terrestrial environmental problems are the spread of desert vegetation, the encroachment into natural vegetation of invasive exotic plants and the decline and disappearance of rare indigenous species, especially of enormous numbers of species of the very diverse flora of the western and south-western Cape. Considerable progress has been made with the cataloguing of rare species and the vegetation mapping of reference areas. Research is also being undertaken which, it is hoped, will open up possibilities for the biological control of such invasive weeds as jointed cactus, Australian acacias and hakea.

The first or pilot phase of a savanna ecosystem project is being completed and has produced a first simulation model of energy flow in the ecosystem. This project is being undertaken in order to improve our ability to predict the consequences of such natural events as drought cycles, as well as of range management patterns on savanna grazing lands and to make possible their improved utilization.



Environmental sciences: A group of scientists visiting Nylsvley, Transvaal, where the first phase of a savanna ecosystem project will shortly be completed.

The Cape sea route is exposed to pollution from shipping and South Africa has a responsibility to contribute towards international studies of pollution in this area. The South African programme has completed its first year of full-scale operation and covers impact areas, estuaries and coastal and ocean reference areas. Background concentrations of heavy metals and pesticide residues have been found to be considerably lower than those in the Northern Hemisphere. Besides being of international importance, the results will make possible the control of pollution along the South African coast.

Inversion problems and the effects of peculiar topographical features cause air pollution problems which are perhaps unique to South Africa. Mathematical models are being developed on the basis of research into the dispersal and transport of pollutants along the Natal coast, on the Transvaal Highveld and on the Cape Flats, to be able to predict the effects of topography and other factors. These models will be useful in planning air pollution control programmes.

Research relating to solid wastes is also co-ordinated within the National Programme for Environmental Sciences. This part of the programme is at an early stage of development but techno-economic surveys have shown, for example, that considerable scope exists in South Africa for the co-ordinated recovery of materials from solid wastes.

FIRI

co-operative industrial research

FISHING INDUSTRY RESEARCH INSTITUTE

Director - DR R J NACHENIUS

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 (value of exports approximately R80 000 000 per annum) and subsidised by the CSIR. Firms which are indirectly connected with the fishing industry are eligible for associate membership of the Institute. The annual income of the Institute amounts to approximately R300 000.

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

The principal role of the Institute is fundamental and applied research for the fishing industry. This is concerned with different products and processes such as refrigerated and frozen whole rock lobster and rock lobster tails, canned pilchards and mackerel, fish meal, fish oil, etc.

The Institute acts also as a technical adviser to the industry in connection with the purification of effluent, the control of odour, the testing of packaging material 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 ensure that the industry keeps pace with the progress in every sphere of fish processing.

Better utilization of catches

Endeavours to make better use of all fish netted by trawlers continue. Two factories already have land-based pilot installations for the acid preservation of fish and are considering the installation of the requisite mincers, mixers and tanks on their trawlers, an ideal location for the acidification of absolutely fresh material. This type of acid preserved fish is already in use in Scandinavia as ingredients of rations for pigs and mink.

The material may possibly be used in dehydrated form as a milk replacer or, with certain small modifications in processing methods, for human consumption. The Institute has acquired a small spray dryer which may be of use in this project. There are indications that the product of one of the commercial undertakings, from which test material is already available, supports good growth of chickens. It appears that the acid treatment does not necessarily destroy the amino acid tryptophan, which is sensitive to acid.

Mackerel, shark and squid are among the fish landed from trawler nets, but are not normally utilized in the trawling industry, either because the catches are small and irregular or because they are not acceptable as edible fish. It has been shown this year that mackerel frozen and glazed with an ascorbic acid solution can be preserved until such time as there is a sufficient accumulation to justify canning. Further, pleasing products have been prepared from shark meat, after leaching to lower the urea level, and from squid. Freshwater eel from our rivers, smoked or fresh, is especially tasty when canned.

Fish meal utilization

A falling off in the world demand for fish meal and the accompanying lower price which from time to time occurs, emphasizes on the one hand the necessity for alternative and more sophisticated fish products, and on the other the necessity of creating a wider field of use for fish meal. The liquid expressed

from industrial fish in fish meal and fish oil production is customarily, after the fish oil has been separated, again mixed with the fish solids, and amounts to almost a fifth of the final mass of the fish meal. This liquid contains soluble protein which can be utilized in products such as a milk replacer where solubility is a valuable property. The material has an undesirably high salt content, but has now been successfully desalinated by reverse osmosis treatment, and its use as a milk replacer for lambs is at present under test.

One of the reasons why a high level of fish meal cannot be used in chicken and pig rations is the effect that the oily portion, mainly, of the meal has on the taste of the product. It has now been shown that with the use of about 1 gram of choline chloride per kilogram diet or 2 per cent of one of several plant oils in the ration, chickens with a neutral taste can be produced, even if the finisher ration contains up to 20 per cent fish meal. The mechanism of this effect is still being studied.

Freak fish meal

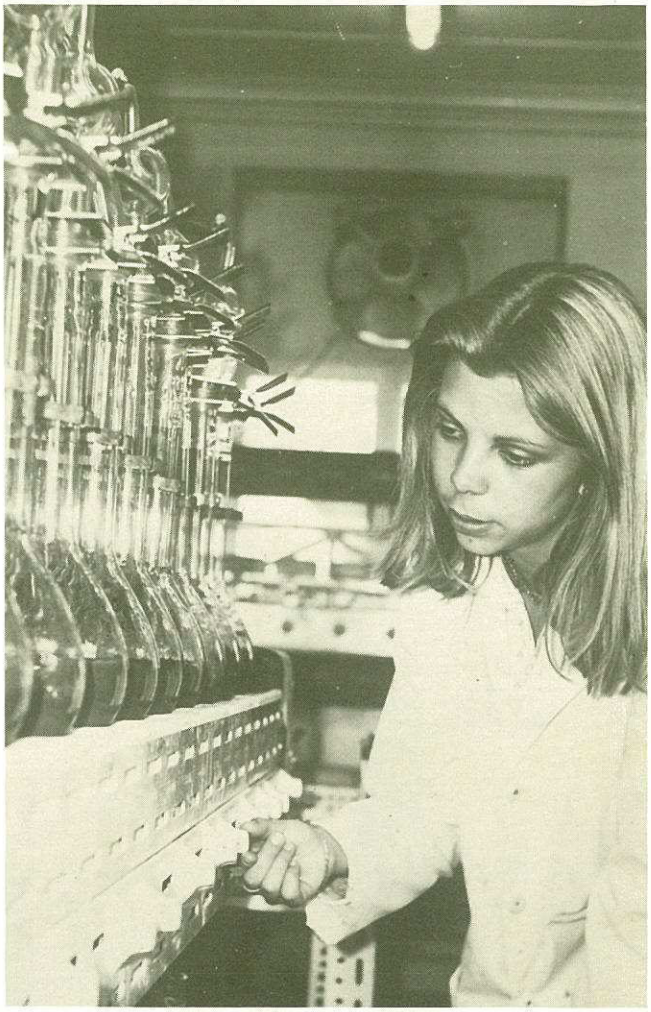
An unusual occurrence which demanded attention was the production by most of the fish meal factories on the west coast of fish meal with a strange unpleasant odour. This problem was attributed to the arrival of anchovies which had spawned abnormally late, apparently had an unusual diet and tended to decompose rapidly. It was shown that they could be preserved with sodium metabisulphite, and that stocks of meal with an unacceptable smell could be deodorized by treatment with calcium hydroxide.

Anti-oxidants and spontaneous heating

Before the general use in the South African fish meal industry of an anti-oxidant in fish meal, the tendency to spontaneous heating of the product had always to be kept in mind. During the latter half of the previous decade the use of the anti-oxidant ethoxyquin was adopted for stabilizing the meal.

For the first time since then, during last season, numerous problems of heating of fish meal coupled with lump formation were experienced. The Institute has found no evidence of consistent negligence in adding the stabilizing material to the meal (although lower levels than those recommended were added in some instances). Samples of anti-oxidant were checked and found to be of normal composition and quality and no grounds could be found to support the idea that the fish used was of special type or in an unusual physiological condition. There is a degree of heat production even in stabilized fish meal and the self heating that occurred was attributed to the storage of uncooled meal in large unventilated stacks.

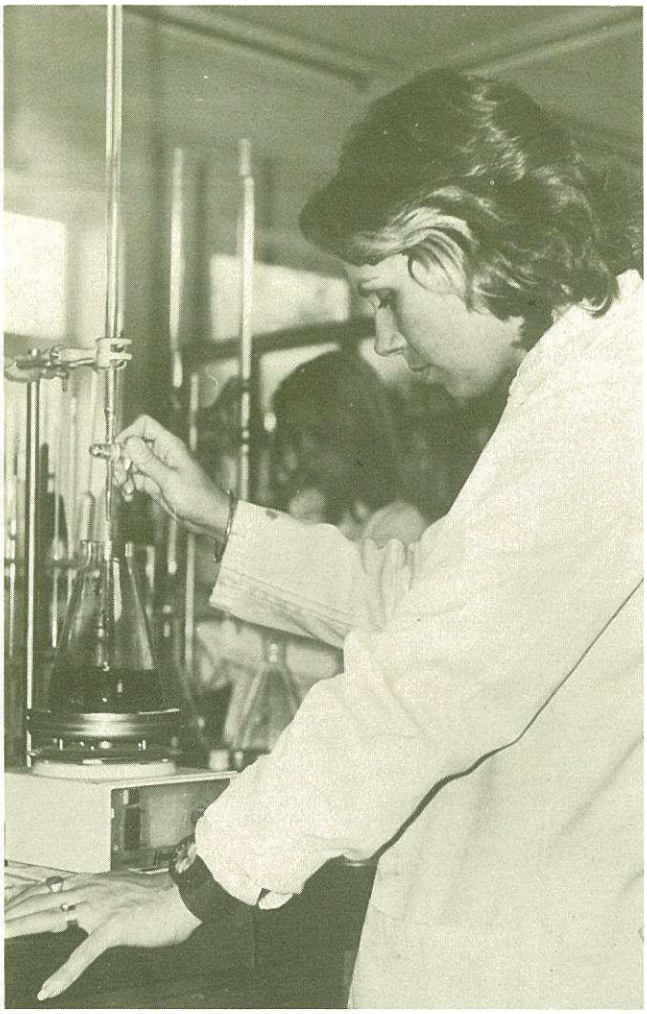
The problems encountered stimulated research work in several directions. The whole question of a suitable and reasonably cheap apparatus for the measurement of the temperature of stacks of loose or packed fish meal was investigated and an apparatus designed and constructed. The pattern of heating and cooling of loose fish meal in large stacks was studied in Walvis Bay and emphasized the importance of cooling the fish meal before it is placed in stacks. Further work is proceeding principally in two directions: to acquire a better understanding of the mechanism of anti-oxidant stabilization and the chemical processes which accompany heating in fish meal — in this connection use of radioactive ethoxyquin will be made — and to find a method of determining the quantity of ethoxyquin which was originally added to the meal. The level of ethoxyquin cannot as such be accurately measured after addition to the fish meal, and after a few months there is no trace of ethoxyquin in the meal, although the meal remains stabilized. It has been difficult to find a non-toxic indicator which could be used as an additive mixed with the ethoxyquin, especially as elements which are found in moderate or variable levels in fish meal cannot be used. It appears that chromic oxide in emulsion or the water soluble ammonium dichromate are the most convenient indicators. Even here there is the problem of the lack of a good method for determining micro quantities of chromium. Chromic oxide is not soluble and is non-toxic. It has been found that ammonium dichromate even at high levels in the ration does not retard chicken growth.



Crude protein determination by Kjeldahl distillation.

Amino acid analysis by gas chromatography

A method for the gas chromatographic determination of amino acids is now established on a routine basis. The technique is based mainly on American procedures which involve the use of N-trifluoroacetyl-n-butyl ester derivatives. Initially there were problems with the quantitative determination of certain amino acids. Histidine determination especially demanded considerable



A stickwater settling test being conducted in the FIRI laboratories.

basic study. The Nα-trifluoroacetyl-N^{im}-carbethoxy-n-butyl ester has been prepared and quantitatively determined. This method relies on the use of two columns and it takes about 45 minutes to analyse a sample. Attention is now being given to a more rapid single column method.

Methods of hydrolysis are also under study; an aspect also of interest to users of ion exchange chromatography for amino acid analysis.

Fish oil

Work with fish oils was largely limited to an expansion of the knowledge of the fatty acid composition of South African fish oils and in some measure of the cooking fats and margarines which contain fish oil. Newly acquired techniques and items of new equipment enabled research workers to analyse fats with greater certainty and accuracy and to separate fractions with differing properties and composition. A better knowledge of the specific isomers of fatty acids occurring in the oil will, it is hoped, lead to a more economic use of fish oils especially in the field of margarine production and the determination of optimum conditions for the hardening of fish oils or of fats containing fish oil.

One of the by-products of the refining of oil for margarine production is an acid oil which inter alia contains the free fatty acids occurring in the crude oil. This fish acid oil has for the first time been used in rations for broiler chickens as a source of energy. Although, mass for mass, it is not as rich in energy as natural oils and at high levels can produce loss of taste or taint in the chicken carcasses, it has been demonstrated that this can be a useful ingredient in animal rations.

Fish bacteriology

Routine investigations which enable managers continually to achieve higher standards of hygiene in fish processing factories is an important service furnished to the consumer. The investigation of the bacteriological quality of smoked snoek is an example of an investigation which helps to determine the source and/or the stage in the production process at which contamination might occur. It is found that fish which are smoked hot — the process used in the case of snoek — are in fact practically sterile. Clean handling after smoking is thus most important and can result in a product of exceptionally high bacteriological quality.

Matters such as the *Escherichia coli* content of the sea water in the vicinity of fish factories and the occurrence of salmonella in fish meal also receive attention. It was, for example, established that the rate of die-off of *Salmonella oranienburg* bears a direct relationship to the degree of fat oxidation occurring in the meal. The contamination of fish meal by salmonella fortunately occurs very seldom. As certain users of fish meal insist on certificates which state that fish meal is salmonella-free a certain amount of control work and research in connection with this group of organisms is still necessary.

Discoloration of rock lobster tails

Since the first half of 1974 a type of rock lobster has been caught in an area south of Port Elizabeth which had not previously been exploited for commercial purposes. This rock lobster, *Palinurus gilchristi*, is closely related to the deep sea rock lobster of the Natal coast, which has been caught in small quantities. This rock lobster has a relatively large tail, a sweet but characteristic taste somewhat different from the rock lobster from the south-west and west coast, and a relatively thin shell which possibly is the reason why tails are more easily damaged and must thus be carefully handled.

Exported frozen rock lobster tails have shown serious discoloration of the meat just under the shell after thawing and were quite unacceptable to the importers. A programme was immediately put in hand to treat the discoloured tails and to avoid further discoloration. It is clear that this discoloration was associated with oxidation, as anti-oxidant treatment largely inhibits the discoloration, but the most practical solution to the problem is more rapid freezing.

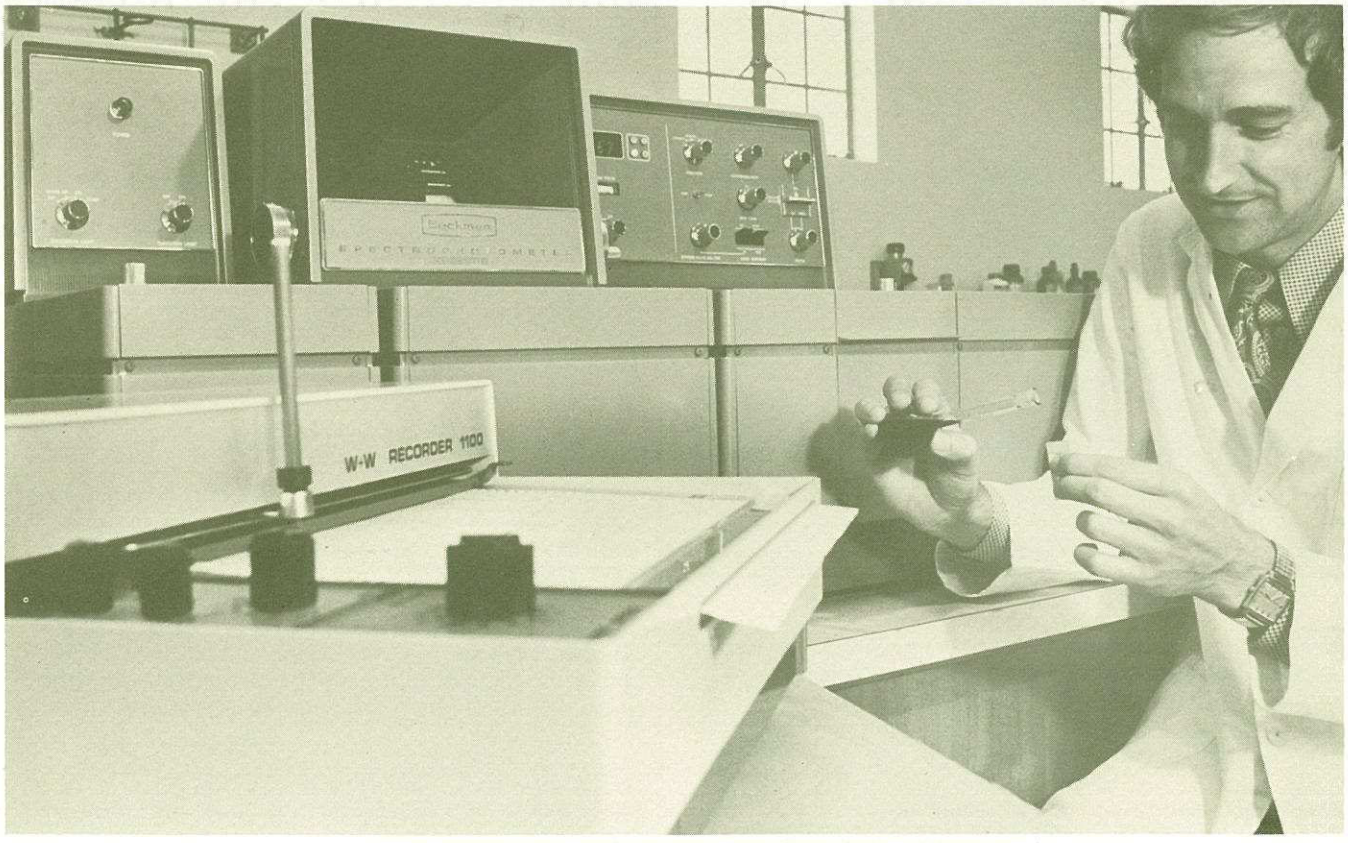
The exposure of millions of rands worth of rock lobster tails to ammonia, after a pipe in the cool chamber had sprung a leak, led to a second crisis which demanded rapid action by the Institute. The greater proportion of these tails could, after treatment with ascorbic acid and repacking, be marketed through the normal channels.

LIRI

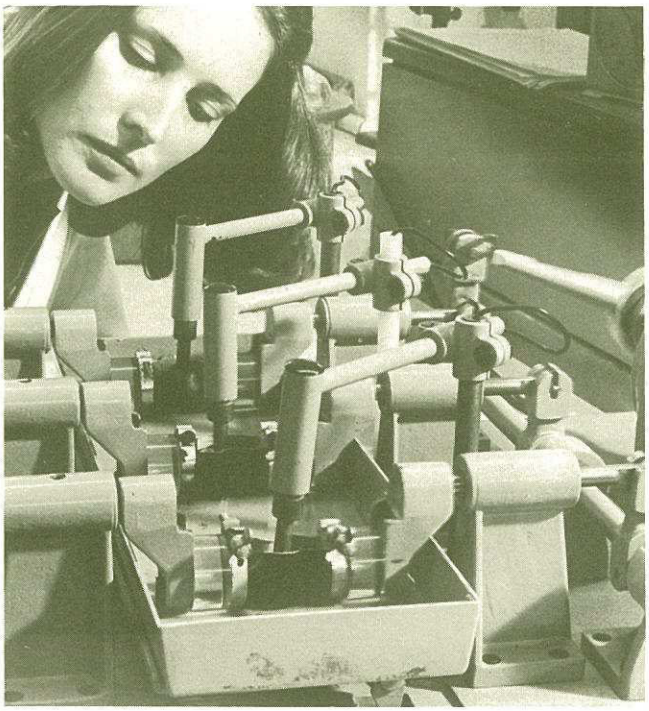
LEATHER INDUSTRIES RESEARCH INSTITUTE

Director - DR D R COOPER

The Leather Industries Research Institute (LIRI) is regarded as the pioneer of industrial research for South African secondary industry. From its early beginnings in 1935 in the Chemistry Department of Rhodes University, the Institute has maintained its steady growth over the past forty years and is now spending some R340 000 per annum to serve industries with an output of about 400 times this figure. A feature of the 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 due to the close personal contact maintained with its many subscribers and the frequency of factory floor contacts between research staff and production staff at all levels.



Spectrophotometric analysis of chromium complexes used in tanning leather.



Determining the water penetration rate on upper material.

Protein research

The reactivity of both soluble and fibrous forms of hide collagen toward various classes of chemical compounds in aqueous solution is being systematically investigated as part of the fundamental research programme. Interaction of simple compounds with collagen provides evidence for the way in which more complex materials such as bacteriostats, wetting agents, tannins, dyestuffs, etc. affect hide collagen in hide-to-leather production.

Hides and skins

The challenge to traditional salt-curing methods, posed by stringent pollution control measures, has prompted research into alternative methods of preservation for hides and skins. Present investigations are aimed at evaluating the effectiveness of a wide range of antiseptic compounds against hide bacterial populations in salt-free preservation methods.

Collaborative studies with the Department of Microbiology, Rhodes University, have led to the isolation for further study of a highly-active bacterial collagenase from South African hides. This enzyme is responsible for downgrading the quality and economic value of untanned hides and skins.

Since stabilization of hide structure by interaction with tanning agents is the most effective long-term preservation method available, further work is directed towards the study of partial tanning methods, using both chrome and vegetable tanning agents.

Investigations into methods of protection and improvement of cured karakul pelts, and the evaluation of pelt quality and physical properties, have been done to assist the producer in enhancing the market condition of pelts, and to provide guidelines for breeding trials.

Wattle-based adhesives

Black wattle bark tannins have been used to develop a range of adhesives for products made from wood. Thermosetting tannin-formaldehyde formulations have been produced for use in the manufacture of plywood and blockboard.

Further, a wattle-based cold-setting adhesive resin has been developed for finger jointing of short lengths of timber and for lamination of structural timber beams. This adhesive has passed the British standard specification for laminating adhesives on European beech wood and has received full approval of the South African Bureau of Standards for use with South African pine timber.

Two types of tannin-based plywood adhesives have been produced; for interior applications an unfortified formulation gives acceptable bonding, while exterior grade plywood requires the incorporation of phenolic fortifiers. The latter formulation has been evaluated extensively by American and European plywood manufacturers.

A fortified tannin-formaldehyde formulation has been developed for use in the manufacture of blockboard, or shutteringboard. Tannin-formaldehyde resins have been developed as fortifiers for starch adhesives used in the production of weather resistant corrugated cardboard containers.

Chemical studies on wattle extractives

A study has been made of the non-tannin components of wattle bark extract, with particular reference to steroids, hydrocarbons, amino acids and sugars. The polymeric bark tannins of the black wattle tree have received further attention. The trimeric flavanoid components have been fractionated and purified by chromatographic methods.

Leather research

Environmental problems are still one of the foremost difficulties facing leather manufacturers. In this regard, the main emphasis of technical research has been on the elimination or reduction of those elements which are undesirable in tannery effluents. Much has been achieved by the re-use of beamhouse liquors, the recycling of used chrome-tanning solutions and the closed system of the Liritan process. The quality of the leather has been shown to be unaffected by the incorporation of the processes. Implementation of such processes would yield a considerable saving in effluent treatment and disposal costs. The recycling of chrome-tanning liquors has the economic advantage of reduced chemical usage.

The knowledge gained from fundamental investigations of the composition of chromium sulphate solutions, the reactivities of the various complexes in these solutions and of the cross-linking characteristics of various compounds, has been used in studies of the chemistry of chrome tanning. Other facets of leather manufacture which have received attention include retanning experiments with metal and formaldehyde modified wattle products, a foam dyeing technique, impregnation studies and solvent systems for finishes.

Environmental research

The Institute is now operating, in collaboration with industry, one small-scale and one full-scale aerobic effluent treatment plant, working on tannery and fellmongery effluent respectively. These use twin surface aerator systems which remove sulphide, lower the pH, reduce COD and BOD and help to coagulate suspended solids. The effect of activated sludge return on the system is being studied.

Footwear research

With the advent of the Mondopoint metric shoe sizing system, a study is being made of methods for the re-calibration of existing lasts, and for the measuring of feet. A new project has been started on the quality control of shoe materials, their use in particular areas of the shoe, and construction methods. The rapid changes in fashion footwear, with the consequent problems in manufacture and wear, make this an important predictive service for the industry.

Industry is showing a renewed interest in safety footwear for factory workers to reduce accidents, so the Institute is examining the construction methods and materials for this type of specialized footwear.

Troubleshooting

The footwear industry uses an increasing number of new materials which have to be assessed. These, combined with new manufacturing techniques and fashion trends, cause problems and shoe returns. The LIRI each year deals with more than 1 200 problems submitted by its subscribers, and solves these both in the laboratory and during frequent factory visits.

Training

The LIRI is responsible for the training of executive and technical staff as well as operatives in the hides and skins, tanning and footwear industries. This follows the Continental system where industrial research and training are operated by the same organization, and has the dual advantage of constantly updating the teaching and bringing the Institute in close contact with industry. LIRI courses have been adopted by many overseas countries.

SMRI

SUGAR MILLING RESEARCH INSTITUTE

Director - DR M MATIC

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

In addition to all South African sugar mills, eleven sugar factories in Swaziland, Rhodesia, Malawi and Mozambique are affiliated members of the Institute.

The SMRI's main functions are:

- *Research:* Study of the fundamental aspects of processes such as milling, diffusion, juice clarification, crystallization of sugar and the utilization of by-products, the raising of steam and power and engineering aspects of the design and performance of mills, carriers, evaporators and vacuum pans.
- *Service:* Advisory work, troubleshooting, analysis of sugar — particularly sugar for export — and statistical compilation of manufacturing data for the sugar industry.
- *Training:* A three-year full-time course in sugar technology is offered in conjunction with the Natal College for Advanced Technical Education. The cost of the course is borne by SASMAL, and while following the course students are employed by the Institute.

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

)iffusion

ıdvantages and disadvantages of the three distinct types of liffusers in operation in South Africa were surveyed, and the rend as regards cane diffusers was noted. These are more ttractive than bagasse diffusers from a capital investment point of iew. The capacity rating of diffusers was found to be uncertain ıut results obtained under South African conditions show that an xtraction of over 96 can be obtained with bed type diffusers at a ibre loading of 0,18 $tm^{-2}h^{-1}$.

he necessity to feed finely prepared material to diffusers in order ɔ obtain good extraction was pointed out and, with experience, iffusers have been found to be capable of processing this type of ɛed. Attempts made to compare the performance of different iffusers have not been successful because of the effect on erformance of cane preparation and the position of the diffuser ı the extraction plant.

The study of the effect of diffusion on boiling house losses, first carried out in 1971, was brought up to date. With additional data available from direct cane analysis it was possible to show that the average increase in non pol across the extraction plant was similar for diffusion and milling factories. There is also no appreciable difference on the reduced boiling house recoveries from the two processes but diffusion factories show a slightly higher production of molasses per unit of non pol in cane.

The conclusions reached were that after seven years of industrial experience, diffusion has proved to be the most economical way of achieving high extraction. Capital and maintenance costs of diffusers are far lower than those of mills required to achieve the same extraction.

Mud filtration and filter cake dewatering

An attempt was made to improve existing filtration techniques by using other filter aids than bagacillo, which is traditionally used for this purpose. The possibility of precoating the filter was also investigated. These tests were carried out with a leaf filter, and the filter aids tested were a commercial expanded perlite, smuts from the boiler stack, bagasse fibre and bagasse pith. None of these products was satisfactory and bagacillo was found to be the best filter aid.

The high moisture content of filter cake adds to the cost of transport of this material and reduces its demand as a fertilizer. A series of empirical tests was carried out to explore different methods of dewatering filter cake.

Pressure up to 6,5 bar applied to the cake in a hydraulic press succeeded in reducing the moisture content of the cake only from 70 to 75 per cent to about 65 per cent. Steam and hot air applied through a hood to the cake on a section of a rotary vacuum filter were not successful. Steam condensed in the cake and hot air glazed the surface of the cake and led to cracking. However, air drying in a pilot rotary drier shows more promise.

On a more fundamental level dewatering of filter cake is being studied using a device to measure the capillary suction time which is quantitatively related to the filterability. The effect of flocculants on dewatering is also being examined.

Heat transfer coefficient and pressure drop in massecuite reheaters

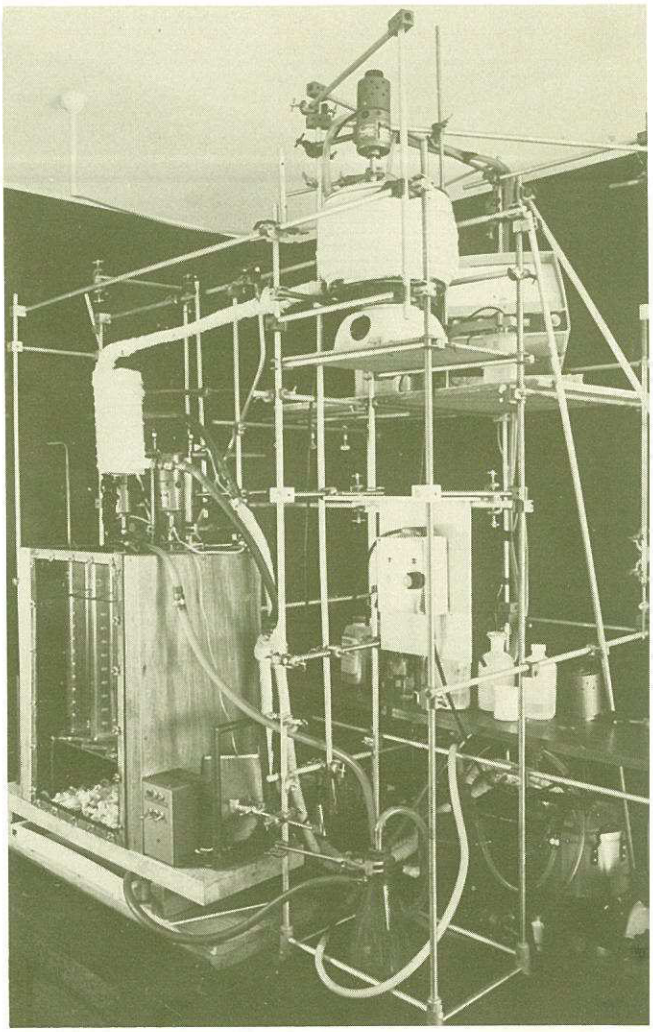
Measurements were made at four mills to obtain sufficient data to establish correlations for predicting the overall heat transfer coefficient and pressure drop in finned tube heat exchangers used for reheating C massecuites.

In the determinations, the heat input and massecuite velocities were obtained by a heat balance on the hot water circuit, and as massecuite is a pseudoplastic non Newtonian fluid its viscous properties were characterized using the power law relationship which it closely obeys.

The data obtained were used to calculate the Nusselt and generalized Reynolds and Prandtl numbers and the Fanning friction factors.

Regarding the heat transfer resulte there is good agreement between three of the factories. The values for the fourth are, however, slightly higher. It is believed that this is because the first three reheaters have tube bundles with the tubes in line, whereas the fourth has a staggered tube arrangement. The latter has been known to give a higher heat transfer coefficient.

The results for the pressure drop studies at all four mills where the measurements have been carried out agree well.



A laboratory clarification unit used in mud filtration and filter cake dewatering experiments.

Kestose preparation

Development of a suitable analytical method for the determination of kestoses has helped optimize the laboratory preparation of these compounds. The actual amount of kestoses in the inverted mixture has now been determined as 4 per cent. Using carbon Celite chromatography the kestoses are concentrated to a purity of between 90 and 98 per cent. As would be expected, the higher purity gives a lower yield. On average a run takes about three days and yields more than 7 g of kestose. By varying conditions, different ratios of the kestose isomers are obtained in the final concentrate and a suitable technique to give high yield of individual isomers has been worked out.

These compounds are required for a study of sugar crystal elongation which has an adverse effect on sugar quality.

financial statements

BALANCE SHEET
as at 31 March 1975

Statement No. 1
Council for Scientific and Industrial Research

	General Fund R	Building Fund R	1975 R	1974 R
ACCUMULATED FUND				
Balance — 31.3.74	30 406 517,96	19 751 196,05	50 157 714,01	45 867 267
Inter-fund transfers	1 308 122,00	523 000,00	1 831 122,00	1096 890
SUB-TOTAL	31 714 639,96	20 274 196,05	51 988 836,01	46 964 157
CAPITAL RECEIPTS				
Parliamentary grants:				
CSIR	1 764 100,00	1 100 000,00	2 864 100,00	2 315 200
Grants	900,00	-	900,00	65 900
Contributions:				
CSIR	7 800,00	5 000,00	12 800,00	14 040
Grants	866,00	-	866,00	450
Interest	-	295 190,50	295 190,50	178 908
Donations:				
CSIR	1 000,00	-	1 000,00	-
Sale of assets written off:				
CSIR	39 057,76	1 830,00	40 887,76	78 249
Grants	125,00	-	125,00	1 200
Investigations and services	1 278 622,88	70 871,68	1 349 494,56	970 509
SUB-TOTAL	3 092 471,64	1 472 892,18	4 565 363,82	3 624 456
ADD				
Excess income	361 182,99	-	361 182,99	210 272
Physical assets acquired	2 140,00	-	2 140,00	(—) 1 282
	3 455 794,63	1 472 892,18	4 928 686,81	3 833 446
LESS				
Physical assets relinquished	-	-	-	35 365
Cost of assets written off:				
CSIR	188 339,23	-	188 339,23	581 209
Grants	27 642,26	-	27 642,26	23 315
SUB-TOTAL	3 239 813,14	1 472 892,18	4 712 705,32	3 193 557
TOTAL	34 954 453,10	21 747 088,23	56 701 541,33*	50 157 714
Current liabilities				
Advances for investigations and services			584 993,88	1 719 127
Sundry creditors and credit balances			2 609 285,63	1 699 865
TOTAL			R 3 194 279,51	3 418 992
GRAND TOTAL			R59 895 820,84	53 576 706

Notes: * Contractual obligations against the General and Building Fund as at 31st March, 1975 were R2 283 271 and R2 699 885 respectively.

ϕ Value of assets transferred: *From:* Medical Research Council R2 140,00

(Sgd.) C v.d M Brink, *President*

(Sgd.) J D van Zyl, *Actg. Secretary/Treasurer*

PRETORIA 6 Aug. 1975

	1974/1975 Nett Additions					
	Grants	CSIR	Written off	Phys. assets transferred ϕ	1975	1974
	R	R	R	R	R	R
XED ASSETS (at cost)						
nd and buildings	-	2 361 985,36	-	-	20 849 531,83	18 487 546
SUB-TOTAL	-	2 361 985,36	-	-	20 849 531,83	18 487 546
boratory and workshop equipment	75 587,64	3 222 508,68	146 471,07(—)	2 000,00(+)	26 526 926,87	23 373 302
rniture, fittings and office equipment	189,34	210 984,29	20 414,41(—)	140,00(+)	1 757 405,45	1 566 506
hicles and cycles	-	203 660,90	47 936,01(—)	-	1 100 183,43	944 458
oks and journals	418,95	190 570,12	1 020,00(—)	-	1 608 925,62	1 418 957
fabricated structures	-	4 807,32	140,00(—)	-	19 270,33	14 603
ares in S.A. Inventions Development Corporation . .	-	-	-	-	200 000,00	200 000
ores stock	-	31 560,88	-	-	594 112,63	562 552
SUB-TOTAL	76 195,93	3 864 092,19	215 981,49(—)	2 140,00(+)	31 806 824,33	28 080 378
TOTAL	76 195,93	6 226 077,55	215 981,49(—)	2 140,00(+)	52 656 356,16	46 567 924
rrent assets						
leable stock					51 969,33	57 507
ndry debtors and debit balances					2 885 827,84	2 045 556
lvances and deposits:						
search grants				597 209,54		
her				1 046 054,49	1 643 264,03	1 245 156
vestments					2 200 456,99	2 759 165
sh:						
At S.A. Reserve Bank				379 834,83		
At other banks				61 634,24		
Petty cash imprests				16 477,42	457 946,49	901 398
TOTAL					R7 239 464,68	7 008 782
GRAND TOTAL . . .					R59 895 820,84	53 576 706

e above Balance Sheet has been audited in accordance with the provisions section 56 of the Exchequer and Audit Act, No. 23 of 1956, as read with tion 14(1) of the Scientific Research Council Act, No. 32 of 1962, and I tify that it is a true and fair view of the accounts of the Council for ientific and Industrial Research.

(Sgd.) J.A Smuts
Acting Controller and Auditor-General

ETORIA
.9.75

OPERATING ACCOUNT
for the year ended 31 March 1975

Statement No. 2
Council for Scientific and Industrial Research

Expenditure	1974/75 Grants	CSIR	Total	1973/74
	R	R	R	R
Salaries, wages and allowances	93 566,99	23 331 575,24	23 425 142,23	19 428 342
Consumable stores and services	11 317,37	9 459 221,39	9 470 538,76	7 389 239
Subsistence and transport	14 620,23	1 273 548,88	1 288 169,11	1 074 823
General expenses	5 218,97	3 016 105,92	3 021 324,89	2 398 756
Subsidies: Research by industry	-	429 040,28	429 040,28	381 886
Grants	1 397 504,69	70,00	1 397 574, 69	1 168 195
SUB-TOTAL	1 522 228,25	37 509 561,71	39 031 789,96	31 841 241
LESS:				
Income for internal services	1 201,27	3 939 929,96	3 941 131,23	3 523 592
SUB-TOTAL	1 521 026,98	33 569 631,75	35 090 658,73	28 317 649
TRANSFERS TO OTHER FUNDS				
(a) Building Fund	-	523 000,00	523 000,00	-
(b) Equipment Fund	-	1 308 122,00	1 308 122,00	-
Excess income transferred to Accumulated Fund	57 503,02	303 679,97	361 182,99	1 307 162
TOTAL	R1 578 530,00	35 704 433,72	37 282 963,72	29 624 811

PRETORIA
6 Aug. 1975

(Sgd.) C v d M Brink, *President*

Income	Grants	1974/75 CSIR	Total	1973/74
	R	R	R	R
·liamentary grant	1 541 400,00	18 739 650,00	20 281 050,00	16 287 750
/estigations and services	-	16 092 028,87	16 092 028,87	12 657 303
ntributions to CSIR projects . . .	34 110,00	666 215,05	700 325,05	533 891
blications	1 645,00	46 777,26	48 422,26	30 878
ndry	1 375,00	159 762,54	161 137,54	114 989
TOTAL	R1 578 530,00	35 704 433,72	37 282 963,72	29 624 811

(Sgd.) J D van Zyl, *Acting Secretary/Treasurer*

CSIR BUDGET 1975/76

Statement No. 3

A. OPERATING EXPENDITURE

ACTIVITIES	EXPENDITURE				FUNDS		
						Recoverable expenditure	
	Salaries	Direct running expenses	Awards and subsidies	Total	Parliamentary grant	Internal	External
	R	R	R	R	R	R	R
CSIR laboratories and departments . . .	26 845 582	18 177 471	-	45 023 053	20 042 000	5 647 709	19 333 344
Grants and subsidies . .	213 430	308 373	3 063 556	3 585 359	2 980 860	87 799	516 700
Total	27 059 012	18 485 844	3 063 556	48 608 412	23 022 860	5 735 508	19 850 044

B. CAPITAL EXPENDITURE

ACTIVITIES	EXPENDITURE							FUNDS	
	Books/ Journals	Technical equipment	Furniture/ Office equipment	Vehicles	Stores stock	Buildings	Total	Parliamentary grant	Recoverable expenditure
	R	R	R	R	R	R	R	R	R
CSIR laboratories and departments . .	164 215	3 543 195	158 530	220	30 000	1 610 000	5 506 160	3 873 760	1 632 400
Grants to universities etc. . . .	1 300	99 240	-	-	-	-	100 540	100 540	-
Total . .	165 515	3 642 435	158 530	220	30 000	1 610 000	5 606 700	3 974 300	1 632 400
						GRAND TOTALS A & B	54 215 112	26 997 160	27 217 95

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

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

VIA
March and September. Summarized reports (mostly of an interim nature) by the National Institute for Transport and Road Research, CSIR. Gratis.

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

NIWR Information Sheet
Irregular. Information on specific water and waste water problems. Gratis.

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

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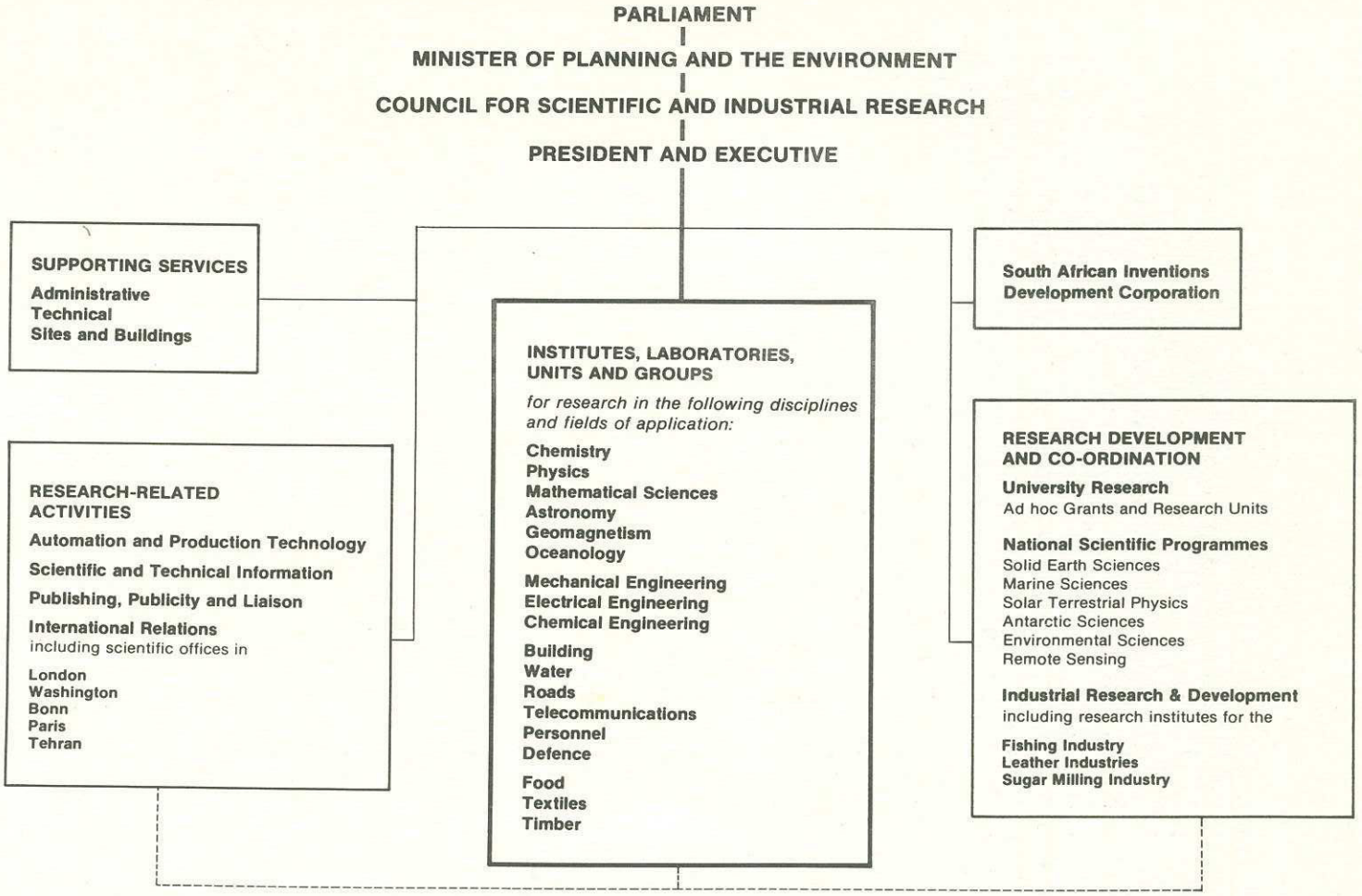
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